EXPERIMENTAL STUDIES IN MENTAL DEFICIENCY: THREE CASES OF IMBECILITY (MONGOLIAN) AND SIX CASES OF FEEBLE-MINDEDNESS.

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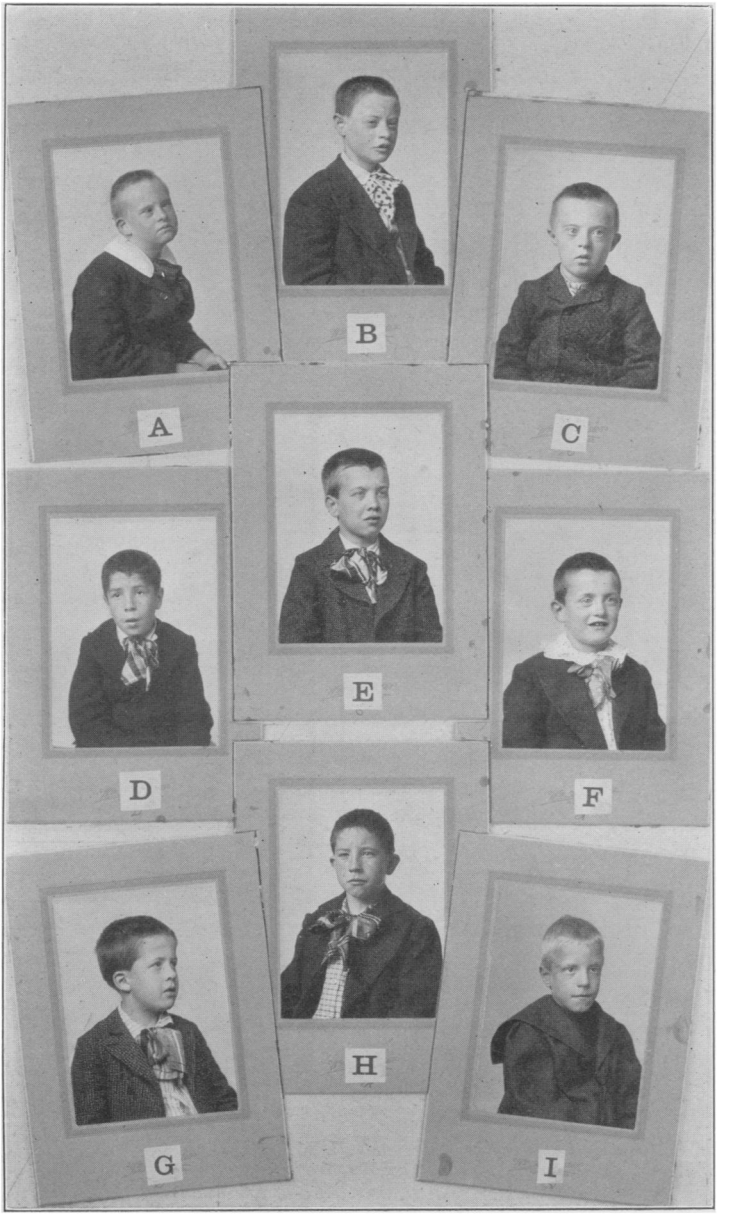
I. INTRODUCTORY.

There is one great need that every reader in this subject, I think, feels; that of accurate descriptive terminology. Many attempts, indeed, have been made to devise a satisfactory classification of all grades and kinds of cases of arrested development and thus arrive at an accurate and uniform terminology that would be really descriptive. It is singular that we have not come nearer to a solution of this difficulty than we have. We have a variety of different classifications, based upon different principles, and combinations of principles, and not one of them is uniformly followed by many writers. The division into idiots, imbeciles, and feeble-minded, according to the *degree* of general development, is perhaps the most common. And yet, even at present any one of these terms is applied as descriptive of all degrees. This mode of procedure is most unfortunate. It has made chaos of much of the literature. For, as a rule, no, or very little general description is given of the cases, so that the reader can form no idea of what sort of a case the writer is dealing with. Particular statements then in regard to his memory, attention, association, and what not, convey but little information, and meet with various contradictions, because they do not hold true of all degrees of defects. After some considerable reading, and a little first hand experience with this class of defectives, I am not convinced that an accurate classification, based upon the degree of general development, is not possible. In fact, I believe that it is, and that the experienced hand can make a further division into low, middle, and high grade idiots, imbeciles, and feeble-minded, without any serious blunders in the actual classification of cases. At any rate, such a classification is extremely desirable when it comes to a comparison of results from different cases. It is the only means to accuracy. The objection to this demand, that it is superfluous, in that when we have the results, the observations on a case, these will themselves show to what grade he belongs,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is largely theoretical only. In actually working with a case and becoming thoroughly acquainted with him we learn much more about him than our recorded results will show. We make our judgments unconsciously, from a mass of data that we lose through not getting it recorded. Thus it becomes comparatively easy to classify a case from first hand evidence, hard though it may be from mere description.

The sources from which our information of the characteristics of children arrested in development has been gathered have been various. In the older literature 'interesting stories,' accounts given by relatives and friends of the case, accounts gathered by courts, when the subject came into conflict with the law, have been pressed into service as trustworthy observations. Another distinct source of information has been the observations gathered by physicians from parents and relatives, when the case was sent to a special institution for training.[1] But by far the larger portion of the literature is based upon general observations made by physicians and instructors on a large number of cases in these special institutions. These methods have been supplemented by a procedure approaching the experimental. A few men have worked out question schema, answers to which would give information concerning the case's early life, his relatives, his early school training, as well as questions directed to the determination of his memory, his general stock of knowledge, his general intellectual capacity, etc. Seguin and Voisin have each worked out a set of 'analytical questions.'[2] Sommer has constructed a more general 'Frage-Bogen' intended for use in the diagnosis of different forms of insanity and arrested development.[3] Möller has done the same on a more extensive scale in a question schema intended only for the latter class of defectives.[4] He claims it to be the here-to-fore needed special method for the determination of the different grades of defectives. Sioli has also constructed one, based on Sommer's, but much more extended, and intended only for cases of arrested development.[5] Finally, a few experiments have been made.[6] These ways of procedure, for most of them hardly merit the name of method, need perhaps no special criticism. Whatever method gives us the in-

[1] Most institutions require application blanks to be filled out, giving answers to questions directed mainly to the history and nature of the case.

[2] Given by Sollier: Psychologie de L'Idiot et de L'Imbecile. Paris, 1891, p. 21.

[3] Sommer: Lehrbuch der psychopathologischen Untersuchs-Methoden. Wein, 1899.

[4] Möller: Ueber Intelligenz-Prüfungen. Berlin, 1897.

[5] Allg. Zeitschr. f. Psychiat., 1900, p. 113.

[6] See Appendix and Bibliography below.

formation we want, and with the least effort, is the best. I wish to say a word only about two,—general observation, and the experimental. The relative merits of the two are the same in mental pathology as they are in other fields. We have not yet learned all about the psychology of arrested development that we can by general observation. But what we have learned in this way teaches us at least two things. First, that general observation cannot take us very far without such a degree of refinement as to make it practically the same as the experimental procedure. Secondly, it has taught us enough about the nature of this class of defectives to know that there must necessarily be a large gap between the kind of experimental tests we would wish to make, if we could, and those that we can make, considering the nature of the subjects. One illusion, then, at least, is removed. The experimental enthusiast must learn first of all, that any pre-conceived plan of experimentation that has been the result of his training in a psycho-physics laboratory is doomed to fail. It is of course important to know that a case cannot perform a certain task set him in an experiment, and the determination of the reason why he cannot is still more valuable. But this does not give us the information for which the experiment was devised, and is to that extent a failure. In general, two principles must guide us in determining what kind of a test is to be attempted. First, the nature of the individual case, his grade of general development, and his special characteristics. Second, the particular tasks that he has learned to do somewhat as a matter of every-day life, or school training. To these latter the experiments must be attached as a modification, so adapted as to give us the information we desire.

Before entering into the statement of the results of the tests I have made, I shall give a general description of each case. The sources upon which this description is based are the physician's records, taken from descriptive applications of each case, required by the institution before a case is admitted, and secondly, my own notes taken from general observation during the four months in which the tests were made. The family histories of these cases, as given in the case-book records, were considered with respect to the possible etiological factors that produced the arrest. They presented nothing that is unusual to such histories; nothing that other studies on large numbers do not show much better. The records for these few cases will, therefore, not be given. Their physical measurements were also carefully taken. The results show no striking abnormalities, and are quite in harmony with those of more extensive studies, which show that these defectives are, as a class, a few inches lower in stature, and several pounds lighter in weight

than normals, on the average. In the following section, therefore, there will be considered only matters concerning their general mental development.

II. GENERAL DESCRIPTION OF CASES.

In the following general description of cases the first part for each case, that under "At time of admission," is taken from the physician's records. The second from notes on my own observations. Cases A, B, and C are those of the Mongolian type.

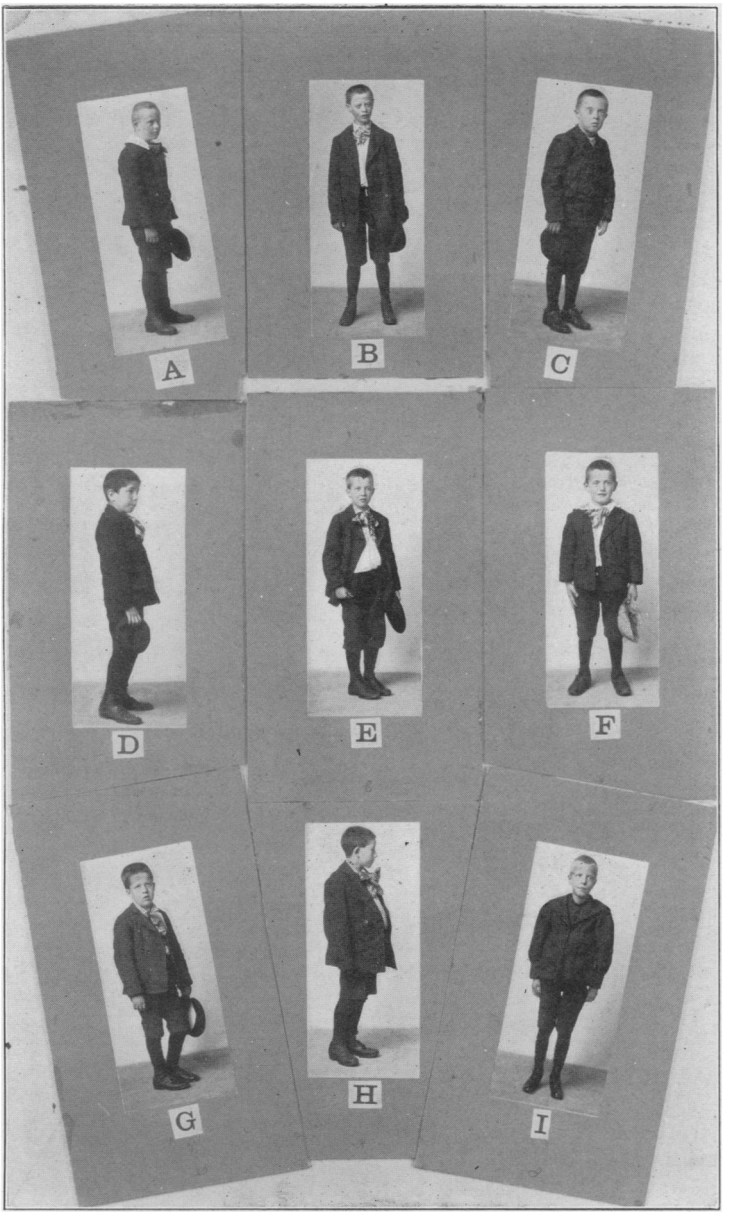
CASE A.

At Time of Admission.

At the time of admission into the institution A was seven years three months old. The first observed signs of mental deficiency were the usual ones in most cases of arrested development. His reaction to common stimuli was retarded. 'He did not notice fire, light, or heat, and was always very quiet.' He began to walk at two and a half years. His habits of cleanliness are, at the time of admission, fair. He has learned to wipe his nose and mouth, and does not soil clothes when in health. He can partly dress and feed himself. Puts on stockings, but cannot tie shoe-lace in regular knot. He can use a fork and spoon, wipe and put away dishes, pick up stones and apples, shovel snow or sand, string buttons and beads, swing child in a hammock. He amuses himself with blocks, marbles, building piles, riding girl's bicycle, looking at books. He is fond of music, recognizes color, and probably knows red, green, and yellow by name. He distinguishes cubes from bricks and pictures so as to know them. He usually understands a command and can do an errand. He talks a little, but is limited to the use of eleven words. There is no speech defect.

Present General Observations.

A is now eleven years, having had four years of institutional life. In degree he should probably be classed as about a middle grade imbecile, and he is a fairly good example of the *stupid*, as opposed to the *active* type. In his general movements he is usually slow and clumsy. In his dullest and least energetic moments he shows every sign of chronic laziness. When busy with a task at the table, he soon collapses from a sitting posture, dropping head and hands upon the table, and forgetting his work. In the different tasks the mistakes he makes seem due not so much to an inability to do the work itself as to a lack of inclination. The effort required seems too much, and he works away in the laziest possible manner. On his brighter days or moments he may become more active, and get even a normal degree of life and energy into his movements. When in this mood he may perform his task with interest, and some degree of attention, varying with the kind of work; for he has his likes and dislikes. A lively mood, however, does not always result in interest and attention to the particular task to which he is set. The extra energy may manifest itself in other directions, in his 'own occupations,' such as humming, pounding on the table, rolling and running after the ball, in a test on throwing at a target, etc. In these instances his attention may go to anything but the thing he is told to do, and when thus engaged in something else it becomes exceeding difficult to divert his attention from it.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As a test of general mental ability, and whatever else it might show, two weeks were spent in teaching him the game of dominos, the first week with myself as one of the players, the second, with myself as observer and with one of the other cases as the second player. Only blocks as high as the double four were used. He had previously learned to discriminate nearly all in a set as high as the double nine, by having one block at a time placed in a circle of ten from which he picked the same block as the one placed in the centre of the circle, two sets of dominos being used in the test. His first difficulty in learning to play the game was in learning to separate the two ends of the block and match by ends only, instead of by blocks, as he had been doing. But after the first few days he had learned all of the purely mechanical procedure of the game. He learned to take three blocks at the beginning of the game, to play by matching an end of his block with one end of the playing line, to wait his turn to play, to draw when he could not play, and to understand that the one who had disposed of his blocks first had beaten. But that he really understood these matters was gleaned from only occasional evidence, evidence that was the exception rather than the rule. About half the time he would not take his three blocks until told. Between fifty and seventy-five per cent. of his plays were wrong. Frequently he would not wait his turn, but keep on playing, his interest being apparently more in stringing out a line of blocks, than to wait his turn, play, and win in the game. He nearly always forgot one end of the playing line, and drew at once when he could not play on the end nearest him. He very frequently overlooked one end of his blocks that would play, and drew unnecessarily. Generally he showed no signs of interest when he or the other player got through first, until he was asked who won. Then he was in most cases interested, especially when he was the winner, in which case he might even laugh and applaud. He very rarely remembered whose turn it was to play first at the beginning of a new game, but generally said "mine" when asked. In general, he showed little interest in the game, none apparently, except in the mere stringing of blocks into a line, possibly some in matching, and most in his recognition of his having won. He plays at random, with little attention to seeing whether he plays rightly or wrongly. He shuffles and pushes about his blocks, knocks them over, and gets them mixed with those of the playing line and of the "bone yard." That it might be to his disadvantage to let the other player see his blocks he never learned, as he did none of the other points of the game.

Case B.

At Time of Admission.

B was admitted at the age of eleven years two months. His abnormality was first noticed at eighteen months, in backwardness in learning to walk and to talk. He began to walk at four, to talk at about six. At the time of admission he does not know enough to wash or dress himself, cannot tie a shoe-lace, but does not soil his clothing. He can feed himself; uses a spoon, but not a knife or fork. He can do no work of any sort. He does not hide things, but breaks and tears them like any very young child. He is not always obedient, but about like a child of four. He is good tempered, except when crossed. He plays with a sled, and, in the house, plays 'moving,' collecting a pile of things in a corner. His hearing is good, but he is very near-sighted. He is fond of music, does not recognize any of the colors, does not know round from square, but can distinguish photos of friends. He can understand very simple language, and a command,

and will do an errand. He talks a little, but pronounces words indistinctly. Uses only short sentences, never putting more than three words together at a time. He does not count.

Present General Observations.

B is now fourteen years nine months old, with three years seven months of institutional life. Not counting the difference in age, he stands quite noticeably above A in general ability, but would come under the imbecile grade. He is normally active and vigorous in his movements. Among the different tasks given him he showed decided likes and dislikes, working with enthusiasm at times, while at others he persistently refused to work at all. His attention seemed to be good when and where his interest was not lacking. Occasionally he would work for a whole fifteen-minute period with practically no distraction. In these instances he would proceed with every sign of deliberation, and apparently never made a *careless* mistake. In memory tests in which he had to choose a card or picture previously shown from among others before him, he would refuse to choose by mere guessing when he had forgotten, and would in these cases not choose any at all. At the times when he was not interested in his work his distractions were due more to his 'own occupations' than to distractions in his surroundings. Yet, the latter, too, were abundant. These 'own occupations' with him were numerous and various, and very difficult to break up, so as to make him return to his work. Some of them were so constant as to deserve the name of 'tics,' so well known in pathological literature, although most of them did not last throughout the four months of observation. Only the habit of making snorting sounds, and of spasmodic laughing remained permanent. Others would appear only a few times, or for several days or weeks, and then cease. But nearly every day one or two would turn up.

The same attempts were made with B in teaching him the domino game as with A and all the others, excepting C. He had also had the previous domino discrimination test. The ability that he attained in it, and the general character of his playing were so much like that of A that they need little special description. His first difficulty, too, was to learn to match by ends instead of by blocks. He, too, readily learned the mechanical procedure of the game, but always played wrongly oftener than correctly. His interest seemed, too, to be in stringing out a line of blocks, perhaps some in matching, but most in winning. He forgot less often than A to watch both ends of the playing line, and had to be asked less often at the end of the game who won, before he recognized the fact.

B's speech has apparently not developed much since admission into the institution. He still speaks indistinctly and brokenly, and uses only phrases or very short sentences.

Case C.

At Time of Admission.

C was admitted at the age of ten years. It was noticed from birth that he was backward in every way; was helpless and could not sit up, but began to improve after the second year. He began to walk between four and five years. At the time of admission he does not yet talk. He 'can say some sounds, but cannot connect them. Says papa, mamma, baby, and a great many other words, but not very distinctly.' His habits of cleanliness are good. He does not soil clothing. He can dress and feed himself. He uses a spoon, knife and fork, but cannot tie shoe-lace in a regular knot. He 'can wash and wipe dishes,

and put them away; bring wood and coal, and other wants about the house.' He is obedient and of good temper. He amuses himself as a normal child would. His sight and hearing are good, he likes music, does not recognize colors, knows none by name, and does not recognize form. He distinguishes pictures, understands a command, and can do errands.

Present General Observations.

C has been in the institution for ten months. He is fairly active and lively, more than A, but not as lively as B. His interests seemed about uniform for all the tests. He never showed signs of any particular enthusiasm, nor of any great dislikes for any of his tasks at any time. From outward appearances his attention was not very difficult to get or to hold. He would generally react at once when spoken to, or when otherwise indicated to him what he was to do, provided he understood. And he would go through any of the tests without much relaxation in interest or effort. But upon more detailed observation it became evident that neither his interest nor effort was, as a rule, very great. He performed his tasks in a thoroughly mechanical way, with little change in manner. He did not understand many of the ordinary questions asked him in connection with the tests, but answered all with an ever ready 'yes' and nod, often before the question was completed. Many instances in his procedure showed that a large part of the time he had forgotten just what he was to do, or at least that he did not have his attention on it at all. He did not have any pre-occupations intense enough to hinder his work very much, nor did he seem to be distracted much by his surroundings. In a word, he seemed to have no particular interest in anything, and perhaps never showed any great effort. His speech was limited to some words that were hardly spoken intelligibly. He was never observed to use more than a word at a time. Many things about the tests he could not be made to understand, and the nature of his reactions to questions quite strongly indicated that the main factor in not understanding them was his lack of attention to them. When confused or astonished his eyes revealed a considerable degree of lateral nystagmus.

CASE D.

At Time of Admission.

D was eight years eight months when admitted. He began to walk between two and three years, to talk at about six years. He 'has a great laxity of vocal organs, speaks very indistinctly, so that strangers do not understand him.' At six months he had an epileptic attack which increased in severity till three to four years when remedied. Since that time it has greatly improved so that he no longer becomes unconscious, and a word will bring him back to normal condition. His habits of cleanliness are fair. He is learning to dress himself quite well, but cannot tie shoe-lace. He can feed himself with spoon, but does not use knife and fork. He can help clear table, and brings in wood up a flight of stairs. He is generally obedient and good tempered; does not hide or destroy things. He amuses himself with pictures and games with his sister. His sight and hearing are good. He is very fond of music. He distinguishes forms and colors, and knows red and blue by name. He distinguishes pictures, can understand a command, and do an errand.

Present General Observations.

D has been in the institution a year and six months. He should be classed above the imbecile grade. He is quite lively and frequently

gives the impression of one of the active type. But his apparent great activity is rather due to a considerable nervousness. He has his likes and dislikes, the latter of which he frequently expresses. But on the whole he is obedient and will perform his task when told to, even though he dislikes it much. In some of the tests he shows a keen interest. He had a strong sense of rivalry, and could not bear to have his opponent beat him. But, although rivalry aroused him very much, it did not improve his attention to his task, and consequently he did no better on account of it. He manifested more than a normal degree of inquisitiveness, with respect to matters incidental to the tests and what they suggested to him. In some of his questions he was very persistent, and frequently refused to continue his task until he was answered. A number of them were repeated every day with no apparent decrease in interest. He found much more means of amusing himself during unoccupied moments than any of the preceding cases, and he would never sit still, doing nothing, when left to himself. Of this much was stereotyped, for he did the same things over and over again with no apparent change in procedure or interest.

D had no difficulty in learning to play the domino game. He learned to match by one end only, and all the other details in the procedure during the first half hour sitting. He showed considerable interest in winning, and apparently kept that object more or less in mind while playing. He understood that drawing was prejudicial to winning and would be much pleased when his opponent was obliged to do so. He very rarely made a wrong play, but very often drew when he could play on either end, and constantly forgot one end of the playing line, drawing at once when he could not play on the end nearest him, without looking at the other. He could not be made to understand that showing his blocks or telling his opponent what he had might be a disadvantage, and he never learned any of the other points of the game. When his opponent played a double leaving the ends the same as those for which he had just drawn he forgot about the fact and proceded to his own blocks before drawing again.

Case E.

At Time of Admission.

E was admitted when eleven years three months old. He began to walk at fourteen months, and could walk alone at sixteen months. He began to talk at three years, but does not speak normally plain at the time of admission. His habits of cleanliness are good. He can dress and feed himself; can button his front buttons, but not those in the back, nor tie a shoe-lace; uses spoon, knife and fork well. He can feed the chickens, carry wood and coal. He is obedient and very good tempered, and amuses himself like normal children. His sight and hearing are good. He is very fond of music, recognizes color, form somewhat, knows black, white and pink by name, and distinguishes pictures. He understands commands perfectly and can do errands. He knows the alphabet, but makes mistakes. He read a little at school, and can count to about ten.

Present General Observations.

E is now twelve years ten months old, with one year seven months since admission. He stands above the imbecile grade. His movements and general behavior are quite normal. He is active and lively, talks freely and asks many questions, such as any normal child several years younger would ask. He is of the delusional type, frequently met among feeble-minded. He believes himself to be particularly bright, thinks none of the other boys can do things so well as he, that he is a

special favorite, that advanced work is given him because he belongs to a higher class. His one constant interest is closely connected with this attitude towards his abilities. Throughout four months of experimenting a certain set of questions and remarks relative to this estimation of himself were repeated almost daily. Occasionally he expressed dislike of some of the tests, but he was in general obedient, and never refused to go through a test when asked in a kindly way whether he would not do so. Like B, E sometimes gave evidence of what seemed to be very attentive work. He would proceed slowly with apparent care and deliberation, stopping long to consider when in doubt. But as will be seen later, these manifestations were no true index of his real powers of attention.

In learning the domino game he showed no appreciable difference in ability and characteristics, in the number and kind of mistakes he made, from that of B. Repeated attempts to make clear to him some of the different points in the game, outside the mere mechanical procedure of drawing and matching, all resulted in complete failure. He was perhaps more pleased than D when he won, but he did not show so much evidence that he kept that purpose in mind while playing, and he also frequently did not recognize that the game was ended when it was.

CASE F.

At Time of Admission.

F was four years one month, when admitted. His deficiency was noticed at six months. At the time of admission he does not yet walk, but is just beginning to talk. His habits of cleanliness are poor. He cannot dress or feed himself, cannot use a spoon. His sight and hearing are good.

Present General Observations.

F is now eight years seven months old, with four years six months of institutional life. He is a typical case of the active type, as opposed to the dull, stupid, to which A belongs.[1] He shows more life and energy than any of the other cases. He throws very swiftly with the ball, runs wildly after it, kicking and rolling it about. Placed in a chair during a test, his hands, feet, and body are in a constant wrangling motion, and to sit perfectly still for even a small fraction of a minute is absolutely impossible. In his constant wrangling he soon pulls a table-cloth off the table, mixes up dominos, cards he is using, pushes or knocks off accidentally everything in his reach. His questions are very numerous, occasioned by a variety of things, and show no constant or coherent interest. They are kept up at a uniform rate independently of answers given, for which he seldom waits, and in which he manifests no interest when given. His interests, in general, in the different tests, are uniformly poor. He shows an almost absolute lack of persistent effort in all of the tests. His attention is aroused by everything about him that he sees or hears, and is as readily distracted by the next thing that his surroundings or fancy supplies. This is the one source of constant attraction and distraction that makes it utterly impossible to keep him down to any particular task for more than a few seconds at a time.

To go through the regular procedure of a domino game proved to be beyond F's attainments; not perhaps because he did not understand the game, for occasional evidence showed that he probably understood as well as any of the other cases, but because he was incapable of hold-

[1] See Kraepelin's classification, Klinische Psychiatrie. Leipzig, 1899. p. 573.

ing his attention down to the requirements, and to keep in mind what he was to do and not to do in each case. As a rule, he showed no interest in either the procedure or in winning, yet a few times he applauded loudly when he won, and got angry when his opponent won several times in succession. Over half of his plays were wrong, although he could discriminate the blocks well enough. The idea of adding a block to the playing line from his own was apparently the main thing in his interest, with that of matching as only a secondary matter. Often he would not wait for his turn to play, or play several at a time; would draw at any time merely for the sake of drawing, and constantly overlooked one end of the playing line and draw unnecessarily.

CASE G.

At Time of Admission.

G was admitted at the age of nine years three months. He began to walk at three years, and to talk at four. No abnormality was noticed until the sixth year, when he would get angry easily and bump his head. He showed no tendency to play with other children, and preferred being by himself. At time of admission his habits of cleanliness are fair. He can dress and feed himself; can use spoon but cannot tie shoe-lace. He brings in wood, helps his father feed stone-crusher, hoes, etc. He does not destroy things, but is disobedient, and his temper is not the best. His sight and hearing are good. He recognizes colors, and knows most of them by name. He recognizes pictures, but not form. He can understand a command and do errands.

Present General Observations.

G is now eleven years six months, having been in the institution two years three months. He is fairly active and lively, but rather awkward in his movements. His running and throwing is like that of a child at least several years younger. He is very quiet, never asks a question and seldom speaks; is very obedient and well behaved, at least in the tests. He never protested against any task, and would persistently keep up a test for about an hour without objection or any great lagging in effort. His interest was quite uniformly good, although he had some preferences. From all general appearances his attention seemed better than that of any of the other cases, and he was capable of putting a considerable degree of effort into his work.

He learned at once the procedure in the domino game and never made a mistake in matching. He remembered at the beginning of each game whose turn it was to play first, understood that drawing was prejudicial to winning, was always much pleased to see his opponent draw and himself to win. He could watch his opponent, correct his mistakes, and direct him in his playing. But he drew unnecessarily about as frequently as D and H, by overlooking blocks that would play on either end, and by overlooking one end of the playing line. He could not be made to understand any of the points of the game, beyond the mere mechanical procedure.

CASE H.

At Time of Admission.

H was ten years five months when admitted. He began to walk at about five years, and to talk at about the same time. At the time of admission his speech is normal, with the exception of a 'sort of a lisp.' His habits of cleanliness are good and he can dress and feed himself; can use spoon, knife and fork, but cannot tie a shoe-lace well. He is

obedient and good tempered and does not destroy things. His sight and hearing are good. He recognizes form and color, knows them probably by name, and distinguishes pictures. He understand a command and can do errands.

Present General Observations.

H is now eleven years five months, with one year since admission. He is normally active and lively, talks freely and asks many questions. He is of a happy disposition, laughs much and is hard to anger. He is interested in the 'why and wherefore' of things; wants to know what the apparatus is for, what the different tests are for, why notes are taken, etc. His interests, in general, are fairly good, and quite regular. He seldom objected to a test, and when he did it was rather in the attitude of a joke; he could always be persuaded to perform his task. He was pleased to get things right. His attention could be called to his work with a word. He was not very readily distracted and was fairly persistent. Like B, he, as a rule, refused to do guesswork and did not choose a picture or card at all when he had forgotten which one it was, rather than to choose at random.

He was very fond of the domino game, and wanted to play it first every day in preference to any of the other tests. His proficiency in it and the readiness with which he learned was about the same as that of G. He understood that drawing lessened chances for winning, was always pleased to see his opponent draw, and wanted to replace those that he himself drew if they did not play. He readily learned to manage the precedure of the game alone, corrected his opponent's mistakes, seldom made mistakes in matching, but overlooked one end of the playing line and his own blocks in drawing as much as G. His interest seemed to be rather in the procedure with the game than in winning, for he frequently gave no sign of interest in the latter at all.

CASE I.

At Time of Admission.

Case I was seven years ten months when admitted. He began walking when a year eight months old, and to talk at about two and a half years. The first observation of defect was that of a convulsion at six months. His habits of cleanliness are fair. He can feed, and undress himself. He uses spoon, knife and fork, but cannot tie a shoelace. He can do little errands about the house, is generally good tempered, and usually obedient, but breaks his playthings. His sight and hearing are good. He sometimes recognizes color, knows red and blue by name, and distinguishes form and pictures. He understands a command, and can do errands. He does not speak plainly.

Present General Observations.

I is now ten years five months old, having been in the institution two years seven months. He is very active and lively, but the activity is of the nervous sort, for he is exceedingly nervous. During the first few weeks he was very quiet, and apparently quite attentive. But upon better acquaintance he turned out quite different. His interests are uniformly poor. He is indifferent to all of the tests, even to those that the others liked well. He never protests, excepting a constant complaint that he is tired, and goes through all with about the same degree of effort, which is very small. A word is generally sufficient to call his attention to his task, but he works exceedingly carelessly. All questions that are asked him receive the same affirmative answer, which is given generally before the question is completed.

There is also abundant evidence of another sort that he does not understand the questions at all through lack of attention. His speech is quite defective. His sentences are limited to three to four words, which often begin with an explosive expulsion of the air in the first word.

He had difficulty in learning to match by ends instead of by blocks in the domino game. All the other points in the procedure he learned quite readily. But as in the other tests, he was very careless, and made very many wrong plays, and seldom kept watch of both ends of the playing line. He seemed to regard the game rather as an imposed duty than as a pleasure, although he showed some interest in winning.

With the cases whose speech was good enough to make their answers intelligible, D, E, F, G, H and I, some time was spent with general orientation questions, similar to those outlined by Sioli, and others. The results obtained with this method were so much alike for the different cases that they may be summarized briefly. It is difficult to determine in this way how much they remember of their past life, and whether their memory in this respect is really defective, and to what degree. But one thing seems to be true of all of them as regards memory. There is a very prominent deficiency in keeping fact and imagination apart. Apparently they relate as actual fact whatever comes into their minds. For the same questions asked on different days receive different answers. Their natural train of associations, unhampered by any voluntary inhibition, determines, in general, what they have to say. Numerous special instances reveal this fact quite clearly. Thus, *e. g.*, when asked what they had for breakfast they may relate a large list of things, including anything they had at another time. It is impossible, of course, to determine just how much this mingling of fact and imagination is conscious or unconscious with them. Yet it is clear at once that probably a large part was more or less consciously done. For, on cross-questioning they would correct their previous remarks. Questions on time orientation revealed that they kept very little track of the days, weeks, months, seasons, etc., and that holidays, and events emotionally connected with their lives furnish by far the chief landmarks, if not the only ones, in their knowledge of the progress of time. Further, they showed that they knew many more names and words than they knew the meaning of, for they constantly misapplied them. This, however, differed much for the different cases. When asked to name the seasons of the year, *e. g.*, they may answer, 'Tuesday, Winter, Fourth of July, and April.' Or asked what month it is they may answer with a day of the week, a season, etc. Their idea of number is exceedingly poor, and questions involving it generally received answers very far from correct. Thus, they may say that there are two hours in a day, twelve weeks in a month, four months in a year, etc. None of them could tell time by the clock, nor had any means of indicating that they had even as much as a very vague idea as to how much of the day was past, and how much was left.

III. EXPERIMENTAL RESULTS.

A. MEMORY.

The tests that were made that would come under this heading were primarily intended for two purposes. First, to determine what the proper method would be for getting evidence that would decide the essential problems that such tests in

general aim at, and, secondly, to get results from the particular cases studied for the sake of comparison with other results.

A large share of the interest in the psychology of arrested development has been directed to the *memory* of this class of defectives. Remarks from casual and general observation on this matter, however, are so general and so various that they afford us but little insight into what the facts may be. The range from profound idiocy to the slightly feeble-minded is so great, the special aptitudes seem to be so common and so marked, and our present knowledge of the class so meagre, as to allow of practically no generalization. Again, the results on the memory span obtained under experimental conditions cannot be compared directly. The methods have been different, and generally too little information is given us as to the age, special training, and the approximate degree of general development of the cases. The following is a résumé of the results of previous experiments on their memory.

Galton tested the memory span of idiots with the reading of figures.[1] He probably uses the term 'idiot' as descriptive of the lowest grade. Their age was 'apparently from sixteen or seventeeen to twenty-five. They could read and write a little, and do some house work, but failed in the adding of two figures.' He tested fifteen cases, reading the figures once distinctly and having the case repeat them orally. He does not state how many individual tests were made on each case. The average of his results from these cases is four, as the number of figures that were perfectly recalled. The three poorest had an average of two figures, and of the six best five had an average of five figures, and one of six. The results of another visit to another institution, where most of the inmates were of the imbecile grade, were as follows: 28 cases tested, classed into four groups according to the estimated degree of general intelligence. In the lower classes letters instead of numerals were read, in all the child beginning to repeat immediately after reading. Class I, ages nine to fifteen, gave an average of 7. Class II, ages nine to sixteen, averaged 4.5. Class III, ages eleven to nineteen, averaged 3.09. Class IV, ages eleven to fifteen, averaged 3.33.

Johnson experimented with seventy-two cases, using the reading of numerals as a method, the child repeating orally immediately as many as it could.[2] He used series of three, four, etc., to eight numerals. Six repetitions of each series constituted a test. Of the seventy-two cases thus tested,

70 repeated 3 numerals correctly.
66 " 4 " "

[1] Mind, 1887.

[2] Psycho-Asthenics, Vol. II, No. 2.

51	repeated	5	numerals	correctly.
27	"	6	"	"
14	"	7	"	"
4	"	8	"	"

Arranging the cases according to the degree of their general development, he concludes that 'there was generally an increase of memory with intelligence, but there were notable exceptions.'

Wylie has tested fifty-one cases on visual and auditory memory, and thirty-four on the memory of muscular movements.[1] The age of the fifty-one cases ranged from fifteen to thirty years. Twenty-five of them were boys. Of the thirty-four, seventeen were boys. He gives no further description. For the visual tests he used three series of stimuli. (1). Ten cardboard forms. (2.) Ten colored papers. (3.) Ten consonant letters on cards. Five of each series were presented to the child for two seconds, and immediately it picked out as many of them as it could from a duplicated series of ten placed before it. Each series was repeated five times. He found the average number of correct choices to be as follows:

	Form.	Color.	Letters.
Girls 26	2.3	2.4	2.5
Boys 25	2.5	2.3	2.7

For the auditory test he used, (1.) groups of five nonsense syllables, as free from association as possible. (2.) Groups of six associated words. (3.) Words making sentences, from their school readers from five to thirty-five words in length. The syllables and words were read at the rate of one per second, the child repeating them immediately. The average number of syllables and words correctly repeated were:

	Syllables.	Words.	Words in Sentences.
Boys	2.1	3.9	10
Girls	2.1	3.7	12

In the test on the memory of muscular movements a graduated rod with two stops was fixed on supports before the child. With closed eyes the child moved the index finger from first to second stop and back. The second stop was then removed, and the child required to move finger again to the position where the second stop had been. Three distances between stops were used, 100, 200, and 300 mm., respectively. Three intervals, 0-seconds, 10-seconds, and 20-seconds, between first movement and reproduction of movement were used. He does

[1] See Psycho-Asthenics, Vols. I-IV, for a number of different experiments made by him.

not state the number of trials for each case. His results are:

	0-sec.	10-sec.	20-sec.
Boys 17	108	111	144
Girls 17	108	113	108
Boys	311	279	271
Girls	287	282	277
Boys	490	463	447
Girls	476	457	456

Grouping these cases into three classes according to degree of general development shows their memory span, and accuracy of memory of muscular movements parallel with the degree of intelligence, in a general way.

Recently, Lobsien, also, has made a memory span test on mental defectives.[1] He used nine stimuli, given to a group of children at ten seconds intervals, for each of eight different classes of stimuli, as follows: (a.) Nine objects seen. (b.) Nine noises made. (c.) Nine numbers called. (d.) Nine words called suggesting visual imagery. (e.) Nine words called suggesting auditory imagery. (f.) Nine words suggesting tactual imagery. (g.) Nine words suggesting emotions. (h.) Nine words whose meaning was not known to the children. The experiment was a repetition of one he had previously made on normal children.[2] In each case the children wrote down immediately as much as they could remember. He compares the results of normals and defectives. The following is taken from his tables. The figures express percentages correctly recalled.

	a	b	c	d	e	f	g	h
Defectives (age 10–12),	71	43	26	39	24	35	31	8
Normals (age 10–12),	87	54	64	61	59	61	51	11
Difference,	16	11	38	22	35	26	20	3

His results, when grouped according to grade of general development, also show that memory span decreases with this grade.

A number of other experiments have been made by different persons on the memory span of normal children and of adults. Comparison of these results with those from children arrested in development shows the latter to be considerably deficient in memory span, at least in the averages, and granting that no other factors have entered with the one class. Thus Johnson, on comparing his results with those of Jacobs, Bolton, and Bourdon, concludes that 'the feeble-minded fall considerably

[1] Lobsien: Einige Untersuchungen über das Gadächntiss bei Schwachbefahigten. Die Kinderfehler; Zeitschr. f. Kinderforschung. Bd. VIII, H. 4.

[2] Lobsien: Experimentelle Untersuchungen über die Gedächtniss-Entwickelung bei Schulkinder. Zeitschr. f. Psych. u. Phys. d. Sin. Bd. XXVII, 1902.

below normal children in memory span. But the memory span is so good in some cases, and the average for the majority is so high, that we are led to conclude that the degree in which the memory span of feeble-minded falls below that of normal children is not commensurate with the degree in which the feeble-minded fall below normal children in general intelligence.' He believes that their deficiency in memory span is largely due to deficiency in attention and will power, and that 'hence we may conclude that weakness of memory, physiologically speaking, is not a special prominent factor in feeble-mindedness.' Wylie's results on the memory of muscular movements, compared with those of Scripture from adult normals show 'the memory error of feeble-minded to be from two to ten times that of normals.' Lobsien concludes from his results that roughly the memory of normals is to the memory of imbeciles as five to three.[1]

Great differences and irregularities are undoubtedly a constant feature with this class of defectives. The fact to which Johnson attributes a general lowering of memory span is responsible also for a great variation, since great irregularity is one of the expressions of poor attention. The extent and nature of this factor is one of the chief things that we need to know more about, for it is evident from only a superficial observation that poor and irregular attention is one of the main lines of deficiency. But in order to do this, and also to determine more closely to what extent they are really defective in memory, it is necessary, I think, to observe a more rigid control of the tests and refinements of method. It is to a few conditions that should be considered, which one learns best after having had some experience with the cases, that I wish to call attention. I have already noted that in comparison of results of different cases with each other and with those of normals in any particular test it is quite necessary that the ages and general development of the cases should be nearly alike. The judgment of general ability can be made with much greater ease and accuracy in observing the cases themselves than such differences can be described, and the demand really involves no great difficulty. But of equal importance with this is the consideration of the amount of institutional training each case has had, and his degree of familiarity with the special stimulus used

[1] See his article in Kinderfehler, p. 202. For results of other experiments on the memory span of normal children, with methods very similar to that of Lobsien, see Netschajeff: Experimentelle Untersuchungen uber das Gedächtniss-Entwickelung bei Schulkinder. Zeitschr. f. Psych. u. Phys. d. Sin. Bd. XXIV, 1900. Also, Ueber Memorieren. Eine Skizzie aus dem Gebiete der experimentellen Pädagogischen Psychologie, by the same author, in Sammlung von Abhandlungen an dem Gebiete der experimentellen pädagogischen Psychologie. Bd. V, 1902.

in the test. Home life and institutional life are too frequently two quite different matters with sickly and defective children. Entrance into the institution often results in a great improvement in general health, when all their special needs are looked after by competent hands. Long and persistent special training adapted to the nature of their deficiencies brings about a second great difference between those outside and those in the institution. When these facts are considered in connection with the effect they may have had upon the familiarity of each case with the special stimulus used in the test, their importance becomes at once evident. Discrimination, and recognition of forms, letters, words, and numerals is with many cases the result of a long process of learning, quite different from that of any normal child, and quite different from each other. What the defective case does in a test depends in the first place upon how well he can handle the stimulus. The figures from Lobsien's tables, given above, strongly suggest this fact. From them it is seen that the difference in memory span for the two classes of children is much less when the stimuli are actual objects seen, and actual noises heard—a, and b—than is the case when the stimuli are only words called suggesting the different imagery—c, d, e, f, and g, h being an exception. The first explanation for this that suggests itself is that the normal children have developed a better word memory through several years of school training which the defectives have not had. In any case, it has long been known that memory is memory for particular things, and that it may be widely different for different things, according to the experience and interests of the individual. Again, if we wish to determine how far the memory span result is due to deficient memory, and how far it is due to poor attention, the first prerequisite is the observance of special means of insuring uniform perception of the stimulus. If several things are merely placed before the child and he is left to himself to see them, it will mean that in some trials he will not notice any at all, while in others his attention may be quite normal. The averages may then be a measure of irregular attention rather than poor memory. The same factor will be present when the child is required to recall or recognize what stimuli have been given. Unfortunately there seems to be no means of eliminating the effect of poor and irregular attention at the latter point. Lastly, if any interval is used between the presentation and recall of the stimulus, it is absolutely necessary that some efficient means of distraction should be employed during the interval. For reducing the effort to keep the stimulus in mind to zero is the only method of keeping that effort uniform for the different cases and for each case in successive trials. Unless this is done the stimulus may, furthermore, be remembered by some symbol, name or other image associated

with it, rather than directly, and the liability and accuracy of memory will then depend not upon the stimulus itself, but upon its associations.

With the observance of these general conditions the details of the procedure in the particular memory test must be dependent upon the particular problem that we wish to study. In the memory span work the problem, as usually stated, is to determine the limit of the ability in recollecting a number of stimuli immediately after a single presentation. The first choice between methods at this point lies between that of the recall and the recognition methods. In the one case the subject reproduces the stimulus, either itself or by symbols. In the other the stimulus is repeated for him together with some others, and the subject has only to discriminate between those presented, and those not presented before. The first, recall method, is the more active process, requiring attention to one's imagery, while, in the second, the recognitive processes are more passive, following immediately the re-presentation of the stimulus. If the feeble-minded are especially defective in attention it is evident that figures in the results of the two methods are not to be compared directly with reference to memory ability.[1] In the majority of cases of these children, however, choice is determined by the nature of the case, and the kind of stimulus that can be employed at all. If speech is very defective, as it often is, a large number of possibilities in method are eliminated. With such cases one is practically limited to the recognition method, unless they can write well and one resorts to the procedure of having them write down the names of the stimuli in recall. If the child has not yet learned the names of the stimuli to be used, *e. g.*, numerals, letters, diagrams, colors, etc., the recall method is also out of the question, for he will have no means of expressing, as in case of defective speech, what he remembers. Thus, in general, the recognition method is applicable with low grade cases where the recall method is not. But it has two decided disadvantages. For, in the first place, the number of things from which the child is to choose those that have been presented before must be kept small; if it is large he will weary of considering them all, and will choose at random. On the other hand, the smaller it is, the larger will be the element of correct guesses.

The memory span work, however, does not decide a number of things that are of fundamental interest in the study of questions that would come under memory studies. Here at once it

[1] The difference between these two methods was frequently verified in my own tests in which a series of ten pictures was used, employing the recognition method. When the child was asked to name the pictures, during the interval, that had been shown him he could usually recall only one or two. But when it came to picking them out from the ten he had no difficulty.

falls into two main lines of problems, viz., 'What is their so-called physiological retentiveness, the inherent persistency of the primary image? And secondly, what is the nature of their memory of a group of associated processes? When we are concerned with the former all possibility of associations with the stimuli must be ruled out. In either case we may concern ourselves with their memory span, or with their memory as dependent upon duration since the stimulus. It is not at all a priori certain that two children with the same memory span will also have the same memory curve as based upon duration. Of associations with the stimuli that are apt to occur the most important is the association between the stimulus and its name. Hence, except in the case in which the effect of their presence is the object of study, an arbitrary stimulus should be used for which no possible name can be invented, and which is also not apt to be remembered by any other symbol. Unless this is avoided our purpose is defeated, for the child may remember the stimulus during the interval by repeating its name to himself, or by some other symbolic representation that would be easier to keep in mind than the stimlus itself, as already noted.

My experiments on the memory of the nine cases described above can make no pretention at having been performed under the favorable conditions and methods outlined. The main result of the memory tests has rather been to raise questions and to suggest refinements of method. Two sets of memory tests were made. One in which the child was asked to name as many as he could of a group of ten pictures[1] that were being used at the same time in the second set of memory tests, a memory span test by the recognition method. After three weeks of memory span work with these ten pictures each child was asked to name as many of the pictures as he could each day before seeing any of them. This was continued for seven days. Then after an interval of five weeks during which they saw none of the pictures in any test, the same was repeated for two days without the pictures being shown. Each time persistent coaxing was employed so as to eliminate as far as possible the effect of mere unwillingness to try to recall them. The following table gives the results in percentages. Only the results of the last two days before the five weeks interval is used in the first column.

In the memory span test the same ten pictures were always used. Each day two, three, four, and five pictures at a time were shown each case, which, after an interval, he tried to pick out from the ten. The whole was repeated sixteen times

[1] Pictures of a goose, chick, pig, cat, horse, shoe, bag, necktie, umbrella, and scissors were used, taken from Reed's card-board object pictures, as advertised in Milton Bradley Co.'s catalogue on Kindergarten Material and School Aids. Springfield, Mass., 1903.

TABLE I.

CASES	A	B	C[1]	D	E	F	G	H	I
Before 5 week's interval	85	75		80	80	70	95	85	80
After " " "	75	75		70	65	65	65	45	75
Loss	10			10	15	5	30	40	5

for each case. In showing the pictures the child was made to name those shown twice over as I pointed to them, so as to secure uniformity of perception. Four intervals were used between presenting the pictures and picking them out from the ten, viz., ten, twenty, forty, and eighty seconds. But the fact that nearly all of the cases remembered at times during the interval by repeating the names of the pictures to themselves quite defeated the purpose of determining the relation between their memory span and the interval between stimulus and recollection. The percentages of correct choices made when two, three, four, and five pictures were shown are given in the following table. The figures given, however, are those after correction has been made for the number that could have been chosen correctly by mere guessing, due to the fact that the pictures were always chosen from the limited number of ten. Thus for the per cent. of correct choices made when five pictures were shown 50% is deducted, for four pictures shown 40% is deducted, etc., from the number of correct choices.[2]

TABLE II.

CASES	A	B	C	D	E	F	G	H	I	AV.
Two pictures shown	80	80	64	80	80	80	80	80	80	78
Three " "	43	57	26	68	66	60	70	70	65	58
Four " "	29	41	27	49	52	38	51	41	10	38
Five " "	20	36	19	44	44	35	31	32	30	32
Average	43	54	34	60	61	53	58	56	46	

It will be noted from the figures that the memory span for these cases, with pictures, lies between two and three. C alone made any mistakes when as few as two were shown, while G and H alone made no mistakes when as many as three were shown. The averages in the lower column have no significance except as a means of comparison of the cases with one another. A comparison with the preceding table will show no direct relation between memory permanency and memory span. The two tables show the order of proficiency in memory permanency during a long interval, and memory span to be the following:

[1] C's speech was entirely unintelligible, and hence no results could be obtained from him in this test.

[2] It will be remembered, however, that this introduces another error at or near the limit of absolute certainty in the memory span. Thus, most of the cases made no mistakes at all when only two pictures were shown, but after deducting for chance error they have only 80% of correct choices.

B — (I—F)—(A—D)—E—G—H, and
E—D—G—H—B—F—I—A, respectively.

Peculiarly, this gives an inverse relation; the four best in memory span are the four poorest in memory permanency. If, from the first table, we compare the order of proficiency in remembering a large number of pictures in the first place with the order according to memory permanency we have:

G—(H—A)—(D—E—I)—B—F, and
B—(I—F)—(A—D)—E—G—H, respectively.

Here G, H, and A, the best in remembering a large percentage of the pictures before the five weeks' interval, are among the poorest in memory permanency. This would correlate high memory span and high proficiency to commit to memory, with a low degree of memory permanency. When we remember from the psychology of memory in normal persons that that portion which is committed to memory under a high pressure of effort and attention is least permanent, then these relations become more intelligible. We may have here an analogous instance. The poorest cases show the greatest memory permanency because they have in the first place remembered only so much as could be done without effort.

Comparing the results for the different intervals, ten, twenty, forty, and eighty seconds, between showing the pictures and their picking them out from among the ten, shows practically no effect of the interval upon the memory span. The averages are exactly the same for all the intervals, excepting the eighty seconds, for which it drops 3%. This was undoubtedly due to the factor already noted, viz., that some of the cases remembered the pictures during the interval by repeating their names to themselves.

Incidentally the test has brought out the fact that there were some instances of decided memory preferences, in the case of the ten pictures used. They would remember some pictures better than others, and forget some more frequently than others. In Table III the percentage of the number of times each picture was not chosen when it had been shown, and the percentage of the number of times it was chosen wrongly, when it had not been shown, are given.[1] In the first horizontal column for each case are given the percentages forgotten, in the second, the percentages chosen wrongly for each picture.

A study of these figures will show that in the large majority of instances those pictures that have been forgotten most are among those that have been chosen wrongly least. The most probable interpretation of these facts is that a certain picture is chosen wrongly more frequently than another because it pos-

[1] The picture of the bag was not shown at all. A chose it wrongly twice, E once and I twice; the others never.

TABLE III.

	Goose.	Chick.	Pig.	Cat.	Horse.	Shoe.	Necktie.	Umbrella.	Scissors.	M. V,
A	18	28	13		22	25	47	13	44	10
	3	3	2	6	3	1	4	5	3	1
B	13	19	6		6	19	19	6	25	7
	3	3	1	1	1	2		2	1	.77
C	13	38	6	19	22	50	47	18	50	14
	8	3	4	6	3	2	3	4	1	2
D	25			6	3	6	3	6	19	7
		2		1			2		1	.66
E	13	13	6		6	3			6	4
							1	2	1	.57
F	25	16	6		3	31		18	13	9
	1	2		2	1		2	4	3	1
G	6	13	6		6	13	19		13	5
	2			1			2	2	1	.79
H		6	19		16	28	3		19	9
	1	2		4			1	2	1	.89
I	50	22	41		19	34	28	13	25	11
	3	3		6	5		2	2	4	1.6

sesses the greater interest. When the child has quite forgotten which the right one is, it is pretty certain that he will choose either the one that is nearest or that his eye happens to rest on, or he will pick according to his likes. Why he should forget one picture oftener than another is more evident. Interest determines the persistency of his imagery. If he likes a certain picture better than the others, or has more associations connected with it, its image will be easier to hold, while at the same time he is incapable of the effort of attention to keep the others in mind. Consequently, he forgets some always, and remembers others. The figures for the picture of the cat show very clearly what the effect of interest has been. Although one would expect that the interests of the different cases would be in different pictures, and this Table III shows, yet the averages show that the pictures themselves have a considerable independent memory value. The following table gives the averages for the nine cases, from the percentages in Table III.

TABLE IV.

Goose.	Chick.	Pig.	Cat.	Horse.	Shoe.	Necktie.	Umbrella.	Scissors.
18.1	17.2	11.3	2.5	11.3	23.2	18.4	8.2	23.6
2.3	2	.7	3	1.4	.6	1.9	2.6	1.8

Here it will be seen that the pictures of the shoe and scissors lead in being oftenest forgotten, while the former leads also in being chosen wrongly least of all, and the latter stands fourth in this respect. Pictures of the cat and umbrella were by far the best remembered, and they are also the two that are chosen wrongly most frequently.

The fact that these results show memory preferences is in itself of no significance. It is only the degree of it, under the particular conditions of the experiment, that is of value. It has long been known that memory with normal persons differs for different things.[1] Unfortunately, on account of the different conditions of my test, my results cannot be compared directly with any others. But that memory preference is a characteristic especially of mental deficiency is seen at once upon comparison of the results in Table III for the different grades of cases. The poorest cases, A, B, C, and I, present the most striking instances of memory preference. The last column of figures on the right, mean variations of the figures in the table, give a measure of the degree of memory preferences for each case. The average of these mean variations for A, B, C, and I is 10.5, and 1.34 for percentage forgotten and percentage chosen wrongly, respectively. For the better cases, D, E, F, G, and H, these averages are only 6.8 and .78, respectively.

B. Practice.

1. *Throwing at a Target.*

In a general way we know, of course, that the feeble-minded are deficient in the ability to gain in practice in any kind of work. The designation 'arrested development' is only another way of expressing the fact that there has been an inability to learn. And to gain in practice is nothing more or less than learning. We know, too, that the details of the nature of the practice curve with perfectly normal persons are subject to very great variations; that these variations are dependent upon the nature of the work, and upon the individual, besides many other minor factors.[2] These things considered, it was the purpose of the following practice tests to furnish some standardized means of studying the factors that enter into the practice curve of this class of defectives, and to compare them with those that we know to be present in determining the practice curve of normals. Granted that the two are different, and that practice gain, especially, is slower with the former than with normal children, a practice test under simple and controlled conditions

[1] From an experiment von Tschisch concludes that memory is different for the different sense departments. See Dritter internationaler Congress für Psychologie in München, 1896, p.95. The figures computed from Lobsien's tables, given above, show how memory differs for different *classes* of stimuli for both normals and defectives. His tables and curves on results from normals alone show this even much better. For an excellent discussion of this and related points, see Stratton: Experimental Psychology and its Bearing upon Culture. New York, 1903.

[2] See especially articles in Kraepelin's Psychologische Arbeiten. Vols. I-IV.

ought to reveal an essential difference in the factors that enter in the two instances. In the present work two motor tests were chosen as best fulfilling the requirements for such a test. One consisted in throwing with an uncovered tennis ball at a large target, the other in tapping on a re-action key in unison with the beats of a metronome. In the throwing test a target forty inches in diameter was used. It consisted of alternating black and gray rings, four inches wide, with an orange colored central spot five inches in diameter bordered by a black ring one and a half inch in width. This orange and black centre gave a good contrast and thus helped to fixate the attention upon the centre of the target, and to avoid throwing at the target in general instead of at the centre. The whole target was marked off into octants. In recording the results both the octant and the ring hit were recorded. The black and orange centre counted five, the next ring four, etc., to the outside ring counting one, and outside of all rings, zero. The target was hung so that the centre was about a foot below the level of their shoulders. To make hitting the centre about equally difficult for all, they were divided into two groups, A, C, and G throwing at a distance of twelve feet, and the others at fifteen feet. Each case threw twenty times a day, for four consecutive days of the week, and continued for seven weeks. Two cases were taken at a time. Every means of exciting their interest and rivalry in hitting the centre was constantly employed. To avoid their becoming weary of their task each day, the two that were taken at a time alternated by five throws at a time. But this seemed to be unnecessary precaution, and, after the second week, they alternated with ten throws at a time. On account of the odd number of cases C generally,—a few times A, and B—threw alone, and after the second week threw the twenty times each day without pause.

In this test there are a number of ways in which practice effect might have been expected. In the first place, the number of points gained per day should increase. Secondly, where there is a constant error, *i. e.*, constant hitting in the same quadrant of the target, this should decrease. Thirdly, the regularity of the throw for each day should increase. Fourth, if there is each day an effect of weariness, so that the last throws on each day are poorer than the first, or if there is an arousal to the task, so that the last throws are the better, practice should effect these factors. Fifth, the daily variations should decrease, *i. e.*, practice should make the results more independent of the changes in daily disposition. The results are insufficient to give any definite evidence on all these matters, and probably because the last three factors—weariness, arousal, and daily disposition are too variable and complex to make a clear

interpretation of the results possible. I shall give the results on these matters in the order indicated.

The practice curves based upon the weekly averages of the number of points gained per day are very irregular, as is seen in Table V. Yet, after the first three weeks it was clear that the curve would not be like that usually obtained with normal subjects. It does not rise rapidly in the beginning, but hardly at all, and soon begins to drop actually below the point at which it started.

TABLE V.[1]

Weeks.	1	2	3	4	5	6	7	Av.
A	37	40.5	38	36.25	36.5	33.75	34.25	36.61
B	41.25	28.5	38.75	36	43.5	36.75	39	37.68
C	38	49	38	36	41.5	——[2]	43	36.61
D	33.25	24.75	30	26.5	29.25	31.75	34.75	39.97
E	44.75	44.5	28.5	39	42.75	43.25	41.75	40.79
F	31	33.75	27.75	22.75	32.25	34.5	31.5	30.5
G	49.25	56.25	55.75	50.25	57.25	59.25	60.5	55.5
H	45	41.75	43	44.5	44.5	40	46.25	43.59
I	32.75	37.5	25.25	24.75	31	21.75	18.75	27.36
Av.	38.36	39.67	36.06	35.11	39.83	37.63	38.86	

The cause for this decline in the curve is not far to seek. Only one interpretation is possible, and many other general observations also bear it out. The novelty of their task soon wears off, they become gradually more tired of it, and hence throw with less interest and attention. The conditions affecting their interest did not remain the same throughout the seven weeks. It is a generally recognized fact that feeble-minded children do better in their general class work when a stranger is present to watch them. This was the case in the present test during the fifth and sixth weeks.[3] On the last day of the fifth week a maximum systematic coaxing was tried, attempting especially to arouse their rivalry, in order to see what effect this would have on the curve. During the sixth week no extra coaxing was employed. The grouping of the results with respect to these factors that affected their general interest and attention is instructive.

TABLE VI.

	A	B	C	D	E	F	G	H	I	AV.
Av. 1st and 2nd Wks.	38.75	34.88	43.33	29	44.63	32.38	52.75	43.38	35.13	39.36
Av. 3rd and 4th "	37.13	36.75	37	28.25	33.75	25.25	53	43.75	25.	35.54
1st 3 days of 5th "	34	43.3	43	26.33	39.33	32.66	60	43	24.66	38.81
Last day " " "	44	44	37	29	53	31	49	49	50	42.89
Av. of 6th "	33.75	36.75	——	31.75	43.25	34.50	59.25	40	21.75	37.63
Av. of 7th "	34.25	39	43	34.75	41.75	31.5	60.5	46.25	18.75	38.86

[1] It will be remembered that A, C, and G threw at a distance of twelve feet, and the others at a distance of fifteen.

[2] Omitted on account of sickness.

[3] Dr. J. W. Slaughter, Docent in Clark University, kindly helped me with the tests and in taking down observations during two weeks.

The main things to be noted in the figures of these two tables are perhaps, first, great irregularity in the curve for each case. In table V the figures are weekly averages, based upon the number of points made in twenty throws a day for four days. Yet the weekly variation reaches 50% in one instance. Many of the daily variations are much higher. Secondly, the matter of interest and effort really to hit the centre has been the main factor in determining the course of the curve. It is only in the general average for the nine cases that any genuine practice effect is noticeable, and here it is slight. The average for the second week stands only a little above that of the first, and after that it clearly drops until the fifth week. Decrease in interest and attention make the curve go down. Thirdly, the extent of the influence of these is seen in the general averages in Table VI. Where a special attempt was made to raise them to a maximum, in the last day of the fifth week, the average is 42.89, considerably above any other average. During the sixth week the average falls again below that of the fifth. What the high average in the seventh week is due to is not entirely clear. In D it was quite noticeable that the sense of rivalry that had been quite well aroused during the preceding weeks continued in the seventh. On the other hand, H, who kept up a high average in the seventh week, did not seem to show any such permanent change in attitude towards his task. However, considering the results on the whole, it is more probable that the high averages of the sixth and seventh weeks are due to the more or less permanent change in attitude caused by the previously aroused rivalry, a change that might readily escape notice in general observation, than that they are directly due to a real practice gain.

Although the actual number of points made per day decreases, thus showing that the effect of practice is less than that of other factors, practice effect is seen in other ways. In throwing at the target most of the cases showed a considerable constant error; they constantly hit in one half of the target more than in the other. This fact has other interests besides that of the influence of practice upon it. But we must note in the first place that with practice the amount of this constant error decreases with most of the cases. Table VII gives the constant errors in percentages for the first three weeks and the last three, for each case.

Thus, for the first three weeks 60% of A's hits were in the upper half of the target, during the last three weeks 64% were in the upper half. The figures in the first two columns show in the first place one way in which decrease in interest resulted in decrease in the number of points made per day. Here it is seen that six of the nine cases, B, C, D, G, H, and I, threw low

TABLE VII.

		Upper half.	Lower half.	Change.	Right half.	Left half.	Change.
A	1st 3 Wks.	10			9		
	Last " "	14		+4	7		—2
B	1st " "	7			13		
	Last " "		1	—8	3		—10
C	1st " "		13			7	
	Last " "		17	+4		23	+16
D	1st " "		3			9	
	Last " "		17	+14		6	—3
E	1st " "		17		2		
	Last " "		3	—14	0		—2
F	1st " "	5			8		
	Last " "	12		+7	2		—6
G	1st " "	4				4	
	Last " "		5	—9		0	—4
H	1st " "	13			3		
	Last " "		3	—16	12		+9
I	1st " "		16		24		
	Last " "		29	+13	11		—13

more frequently during the last three weeks than during the first three. With lack in interest has been correlated a lack of effort to throw hard enough. The other three have increased the speed of their throw, two of them, A, and F, increasing their constant error, and the other, E, decreasing it. On this account these figures comparing the number of hits in the upper half with the number in the lower half lose their significance as regards the effect of practice upon the constant error. But the others show that seven of the nine cases have decreased their constant error in the right or left half of the target, while C and H have increased it. The reason why there should be such a constant error in the first place is undoubtedly that a characteristic swing of the arm and manner of grasping and releasing the ball in throwing has already become fixed, and this is, to the extent of the error, out of adjustment with the perception of the spot that is aimed at. At the same time it is safe to say that the correction of the error has not been a conscious correction. It is not to be supposed that any of these children noticed that they threw 10 to 15%, for instance, more frequently in one half of the target than in the other, and consequently made allowance for such an error. The adjustment, then, has been an unconscious one, and involved the breaking up of a more or less established motor habit.

A second way in which the results show a real practice effect

is in an increase in the regularity of the throw. The hits tend to accumulate on the intermediate rings of the target, thus approaching a sort of an average throw. In table VIII the results of the first three weeks and of the last three are again compared with reference to this point.

TABLE VIII.

	A		B		C		D		E		F		G		H		I		AV.	AV.
0	62	70	72	66	63	51	99	87	60	56	93	94	22	13	48	52	83	120	66.89	67.67
1	39	41	39	30	47	31	32	40	39	32	37	23	32	23	42	36	45	35	39.11	32.33
2	36	54	47	47	31	45	47	42	45	47	37	43	48	35	42	51	39	35	41.33	44.33
3	37	41	34	49	50	49	32	36	36	52	39	45	65	81	55	40	37	24	42.77	45.22
4	32	24	31	34	25	30	20	24	31	36	22	26	43	68	32	40	27	15	29.22	33
5	15	10	17	14	23	14	10	11	19	17	12	9	30	20	20	21	8	11	17.11	13.11

The first vertical column for each case gives the number of hits for the different rings of the target during the first three weeks, the second vertical column gives the number during the last three weeks. The figures 0 to 5 in the first column designate the rings of the target, 0 standing for outside all rings, and 5 for the centre. In considering the averages in this table it will be noted that the 0-column for the last three weeks is high on account of the very exceptional record of I. From the preceding table it will be remembered that I increased the number of hits in the lower half of the target 13% during the last three weeks. The records of his individual throws also show that during this time he threw below the target, outside all rings, much more than at first. Consequently the average of 67.67 in Table VIII is too high, it being raised not by an increase in irregularity of I's throw, but by his becoming weary of the work and too lazy to throw hard enough. This exception aside, it is seen that during the last three weeks the hits accumulate on rings 2, 3, and 4 at the expense of the others. In Table V the average of the average for all cases for the first three weeks is .74 lower than the same average for the last three weeks. Thus the first and last three weeks is practically the same. The increase in regularity of the throw is, then, independent of any factor that increased or decreased the number of points made. This is true not only of the general averages, but also of the exceptional cases whose throw became gradually poorer, although more regular. This is seen best in the results of A, and E, in Tables V and VIII. Taking these facts together, it is clear that in this increase in regularity we have to do with a genuine practice effect. As to just what in the total process the practice is to be attributed, there may be some question.

So far only two factors, viz., interest and attention, and practice, have been noted that entered in determining the number of points made in throwing. There remains a third, daily disposition, a very important one, as will be seen. In Table IX

are given the daily mean variations in the number of points made per day, for each week. Here the 6.67, *e. g.*, for A is A's daily mean variation during his first week. It is seen that the general averages for all cases in the lowest column change from week to week. They show an interesting relation when

TABLE IX.

Weeks.	1	2	3	4	5[1]	6	7
A	6.67	9.25	.5	5.13	1	2.75	8.25
B	5.75	9	7	2.5	7.57	3.75	2
C	4.22	2	7	2	4.67	——	2.5
D	5.63	8.63	11	3.25	1.78	4.75	5.75
E	2.38	6	4.75	3.5	6.44	2.75	5.25
F	6	4.25	3.38	4.25	3.11	9.25	4.25
G	4.75	4.75	5.25	4.25	6	4.38	3.5
H	2.5	5.75	3	3.5	8	3.5	7.88
I	4.25	3.5	6.25	4.13	5.55	3.75	3.88
Av.	4.88	5.90	4.24	3.60	4.90	4.36	4.81

compared with the general averages in Table V, giving the average number of points made from week to week. This shows that the daily mean variation runs parallel, week for week, with the number of points made each week. It is greatest on the weeks in which the number of points made is greatest, and smallest where the latter is smallest. Now, since the daily variations are due to changes in the daily disposition, incidental factors aside, this means that the high averages in points made are due to great spurts on days when they felt inclined to do so, when their general disposition was good. This fact taken in connection with the results previously stated makes it possible to account for the changes in the daily mean variations from week to week, and also the interpolations of all the main factors that entered in determining the curve. It was seen before that the averages in the number of points made fell during the third and fourth week, and rose again in the fifth; and that this was due first to a decline in their interest in the task, and second, to an increase in that interest when, during the fifth week, it was artificially aroused. It is seen now that high records were due to a favorable daily disposition. The effect of these two factors, high interest and favorable disposition, upon the curve should, a priori, be the same. Each should raise the average. Their character, psychologically, is alike, in so far that high interest in a particular task means favorable disposition towards that task, and *vice versa*. But interest is dependent upon the particular task, may be limited to it, is, in

[1] The mean variations for the fifth week are based on the first three days of the week only, since on the fourth day of that week the throwing was better on account of the special and systematic coaxing introduced then.

the present case, highest in the beginning and soon wears off. Daily disposition, on the other hand, is independent of the particular kind of work, varies independently of it, and is probably connected with changes in health, general metabolism, and the like. Now what the figures in Tables IX and V suggest is that favorable disposition did not necessarily imply high interest in the particular task, but that the former was necessary for the latter. For, during the first two weeks high variations and high averages in the number of points made go together. When that interest drops during the third and fourth week, lowering the averages, the mean variation drops also, showing that the changes in daily disposition did not alone effect the curve materially in the absence of the other factor. With the artificially aroused interest in the fifth week the averages rise, but the mean variations rise also, showing that the possibility of arousing their interest was dependent in the first place upon their favorable disposition.

Two other facts, one obtained from general observation, and the other seen in Table V, enforce this interpretation. It was frequently illustrated that a particularly lively mood on a certain day did not necessarily mean an increased interest in hitting the centre of the target. The unusual energy was spent, naturally enough, in other ways, in bouncing and chasing the ball about the room, *e. g.*, rather than in an activity which they had come to dislike more or less. Secondly, it will be remembered that case A was described as one of 'chronic weariness.' In other words, he had a permanent unfavorable disposition. In accordance with this, Table V shows that he is the only case whose weekly averages were unaffected by our effort to arouse his interest in the fifth week.

2. *Tapping on a Re-action Key.*

The tests in tapping were intended for a study of their attention and other things, besides that of practice. I shall consider at present only those results that are concerned the more immediately with practice. The apparatus consisted of the reaction key, some dry batteries, a kymograph, a pendulum at first, and later a metronome, for a time-marker, and two DePrez signals. The record on the kymograph drum, then, consisted of the tracings of the individual taps made by the child on the re-action key, together with that of the time-marker, which was set to half second beats. Four groups of tests were made. In all the child was seated at the table with his right arm and hand, with which he tapped, resting comfortably on the table, and facing away from the apparatus. In the first group the tapping was at his natural rate, the child being told simply to tap, all suggestion of any particular rate

being avoided, but he was always promptly urged to go on whenever he stopped altogether. To avoid any sounds of the apparatus suggesting any rate, a pendulum was used for a time-marker instead of the metronome, used later. In these tests each case tapped for a minute a day for four days. A record was taken of every such minute series. In the second group all the conditions remained the same, except that the child was told to tap just as fast as he could, and every possible means of encouraging a maximum rate was constantly employed. This was continued for three days only. The third and fourth groups were intended for practice tests primarily. They consisted of regulated tapping, the metronome being the regulator, and at the same time the time-marker, instead of the pendulum. The child was told to tap in unison with the beats of the metronome. All the apparatus except the button of the reaction key and the metronome was screened from the child, so that he could not see and watch it by turning around. In the third group the metronome was set to half second beats, this being a rate a little slower than the natural rate of tapping of most of them. Five one-minute series were taken each day, with a few minutes between series, and continued for six days. A break of three days followed the fourth, but this did not affect the results noticeably. Records were taken of only the second and fourth one-minute series of each day. One of the unrecorded minute series each day was taken passively, that is, the child's hand was taken and made to tap in exact unison with the metronome. In the fourth group the only change was that the metronome beat at second intervals instead of half second, and the test was continued for only two days. In the regulated tapping it was intended to study the nature and amount of improvement, and the factors that would enter to prevent improvement, as in the previous tests in throwing at the target. In counting the records the number of taps were grouped into five seconds intervals, these being small enough for the practical purpose of determining the amount of improvement. If, then, the child got in the ten taps for each five-second interval, during the third group of tapping tests, the record was regarded as containing no mistakes. Thus in dividing the counts into five-second intervals, there were in each minute series twelve chances to get in the right number of taps. The results of the regulated tapping are given in Table X.

In the first two horizontal columns the average number of taps per five seconds in their natural rate, and the mean variation from that rate, respectively, are given for each case for the sake of comparison with the other figures. In the first vertical column for each case are given the percentages of the number

TABLE X.

		A		B		C		D	
Average in natural rate,		17.82		12.90		19.94		12.79	
M. V. " "		3.28		2.66		2.19		1.12	
Tap per half sec.	First half,	41.6	1.54	50	1.73	53.33	1.07	68.3	1.05
	Sec'nd "	25	1.6	16.66	4.2	63.33	2.83	73.3	1.5
Tap per second.	First half,	41.6	2.86	29.1	3.18	79.1	1.4	79.1	1.4
	Sec'nd "	16.6	2	16.6	2.65	45.8	1.23	83.3	1
Average,		31.2	2	28.09	2.94	60.39	1.63	76	1.35

E		F		G		H		I			
20.19		11.88		17.5		10.78		16.94			
2.96		1.32		1.87		.85		.78		Av.	Av.
16.66	3.58	66.66	2.8	66.66	1.25	85	1.22	41.66	1.6	54.36	1.76
5	3.54	65	1.9	76.66	1.21	80	1.33	70	1.77	52.77	2.21
20.8	2.89	70.8	1.86	——	——	83.3	1.75	79.1	1.80	60.36	2.14
8.33	2.68	70.8	1.71	——[1]	——	91.7	1.5	70.8	1.29	50.49	1.75
10.2	3.17	68.32	2.07	71.66	1.23	85	1.45	65.39	1.62		

of times the correct number of taps were made in the different five-second intervals in the regulated tapping. Thus the number of times A got in the right number of taps, *i. e.*, ten during the first five[2] one-minute series when the metronome beat half second intervals, was 41.6% of the total number of chances he had to get it correct. The second vertical column for each case gives the mean variations in the number of taps from the correct number. The averages below are averages of the figures in the table, and serve only as means of comparing the cases. The results are very irregular, as is seen, and give little information as regards practice. The averages on the right, however, show that their tapping became poorer during the second five one-minute series; that it was best in the beginning of the next group of tests, in which the rate was changed from half second to second taps, and that it dropped to the poorest immediately after that. There is no question but that this is due to the same factor, viz., losing of interest, which mainly determined the curve in the throwing records. With the slight variation in the procedure came a new interest, but this disappeared at once. The main interest in the table, however, attaches to its analysis, which in connection with the general observations made during the test shows what factors entered in determining for each case the percentage of the number of times the right number of taps were made in the five seconds. In watching them during the tapping several factors were found to be prominent in determining the nature of their tapping. The large variations were almost entirely due to their getting

[1] Omitted on account of sickness.

[2] The test was continued for six days, as was stated, but on account of unavoidable omissions on the sixth day for some of them, the results for all cases are those of only the first five days.

tired of it and stopping altogether, by being distracted by something and stopping, or by willfully tapping much too fast. Thus A's mean variation was raised almost entirely through his stopping because he was tired of it and did not like to continue. The same was less true of B, but he also stopped frequently through distractions, and as often willfully tapped too fast. E's variations were high on account of his frequent alternately tapping very fast and then suddenly stopping again, showing apparently an absolute inability to get his attention on the proper rate. F's variations were raised mainly by stopping through distractions, this being a general characteristic of the case. C and I, especially I, seemed to tap mechanically with a quite regular rate independently of where their attention was. In fact I had a strong tendency to tap at his natural rate, and had difficulty in changing it to a slower rate. D, G, and H were the only cases that seemed to keep their attention regularly on the tapping, making few stops, and never purposely tapping too fast. All these factors in the other cases entered, of course, in decreasing the number of times the correct number of taps would be made in the five-second intervals. But it will be remembered that in the regulated tapping the rate was slower than the natural rate for any of the cases, as is seen in the table. To overcome this natural rate was thus a part of the difficulty for all of them in the regulated tapping. The next table will show what relation this tendency to keep to the natural rate, together with the other factors, has borne to their tapping in the regulated series. Table XI is made up from Table X. It gives simply the order in which the cases stand in regard to four things. In the first horizontal column is given the order according to their proficiency in tapping in unison with the metronome. In the second is given their order according to their variations from the correct number of taps for the five-second intervals. In the third is given their order according to their natural rate, the one with the slowest natural rate standing first, etc. The last gives their order according to their variations in their natural rate.

TABLE XI.

	A	B	C	D	E	F	G	H	I
Per cent. correct,	7	8	6	2	9	4	3	1	5
Variations in regulated series,	6	8	5	2	9	7	1	3	4
Natural rate,	7	4	8	3	9	2	6	1	5
Variation in natural rate,	9	7	6	3	8	4	5	2	1

Here it is seen that the order in the first column keeps quite close to that in the others, throughout, for the nine cases. I is an exception in his variations in his natural rate on account of the purely mechanical nature of his tapping, which made

him very regular in the non-regulated series, but it was too fast, and in his attempt to adjust it to the proper rate his tendency to the natural rate is well expressed by the order in which he stands in the first and second columns. G has a high natural rate, but he stands first in general development and his greater ability of attention gives him the rank he has. F's natural rate is close to that of the first group of tests in the regulated tapping, but his great tendency to be distracted raised his variations, while at the same time he ranks fair in the first column because he tapped with good attention during the intervals between distractions. B's natural rate is favorable to the regulated rate, but his great variations, due to the factors mentioned, make him rank low. The other cases need no special comment, for it is seen that their natural rate and their tendency to vary contributed about equally to their proficiency in the regulated series. The general average in the mean variations in Table X does not decrease, and this is due to the fact that whatever practice effect there might be decreasing it, is over-balanced by their becoming tired of the work and thus becoming more irregular through stopping, etc.

The throwing and the tapping tests were the only two that were primarily intended for the purpose of studying the factors that would enter in determining the changes in their proficiency in the work as it was continued. Some of the other tests, however, also furnish evidence on the nature of these factors, but the statement of these results will be postponed until we come to the consideration of the other results of those tests.

C. Attention and Effort.

1. *Tapping on Re-action Key.*

That feeble-minded children are defective in attention and will has been the statement of every observer that has written upon the subject. Indeed, this defect has been regarded so fundamental that Sollier has made it the basis for the classification of all cases of arrested development, and he thus proceeds to classify them into three grades according to the degree of their defective attention. But this is a broad generalization, and too abstract to present any definite picture of concrete instances. Besides, general observation, upon which alone the analysis rests, can make only a very rough and inaccurate quantitative measurement.

The tests grouped under the present heading were aimed at two things mainly. First, to get some sort of measurement of the degree of effort they were capable of putting forth in a particular task. And second, to measure their attention span. Under the first, two sets of tests were made. One consisted in comparing their maximum rate of tapping with their natural

rate. The other determined their association and discrimination time in four different ways. The tapping test has already been described. In the maximum rate series every effort was made to make them increase and keep up their speed, by coaxing, by arousing their rivalry, etc. In the next table the average maximum rate and the average natural rate for each case is given.

TABLE XII.

	A	B	C	D	E	F	G	H	I	AV.
Av. natural rate,	17.82	12.90	19.94	12.79	20.19	11.88	17.5	10.78	16.94	15.64
" maximum rate,	18.72	12.85	21.75	17.89	21.95	14.81	16.31	12.83	18.37	12.28
Difference,	.90	-.05	1.81	5.10	1.76	2.93	-1.19	2.05	1.43	1.64

This gives the general averages of the number of taps per five seconds for each case. It is a rather surprising result. For it shows that they are practically incapable of any voluntary effort whatsoever. Perhaps some allowance must be made for the fact that the maximum series was given after the other, and they were probably already getting a little tired of the test. But that too would only show that they are unable to overcome by their own will their disinclination to do a certain thing. The average maximum rate of the average adult normal person is considerably above twice the average in this table, and their average natural rate is just about what an easy-going natural rate of a normal person would be. It is also seen that in a general way the difference between their natural and their maximum rates increases with the grade of general development. A, B, C, and I are the poorest cases, and they stand lowest in their differences. G is the only exception, his difference being negative, although he stands highest of the nine cases in general development.

In close connection with this incapacity for voluntary effort in raising their maximum rate above their natural stands the matter of their fatiguability, and the capacity to overcome the effects of fatigue by effort. Wylie, in a similar test in tapping, finds the difference in the number of taps during the first five seconds and the last five of a forty-five-second series to be small.[1] Hence they apparently show but little effect of fatigue. In a dynamometer strength test he finds their deficiency very great. But he remarks that 'taking the weight and height as an index of muscular development, we conclude that fully three-fourths of the deficiency in muscular power must be due to some central defect, as lack of nerve power, or will power.'[2] In the next table are given my results. In the first vertical column is given the general average of the number of taps of all of the first, second, and third five-second intervals, *i. e.*,

[1] Psycho-Asthenics, Vol. V, 2. [2] *Ibid.*

average number of taps per five seconds for the first quarter of the minute series, etc., for the other three vertical columns. The last vertical column on the right gives the difference between the rates for the first and fourth quarter minute. The averages at the foot are averages of the figures in the table. The first thing of interest in this table is the fact that their natural rate decreased after the first fifteen seconds. It is of course clear that there should be practically no fatigue in normal persons, tapping at this rate. The decrease in rate with these children is undoubtedly due to two factors. One is that their attention tires at once. That is, they cannot keep in mind the idea of keeping up their task. After the first several seconds their mind wanders to other things, and the rate

TABLE XIII.

		1st	2nd	3rd	4th	Dif.
A	Natural rate,	20.42	16.25	17.58	16.58	3.84
	Maximum "	21.78	18.22	15.11	19.11	2.67
B	Natural "	15.50	12.42	13.17	14.02	1.48
	Maximum "	15.33	13.78	13.11	10.50	4.83
C	Natural "	21.66	19.90	19.15	18.23	3.43
	Maximum "	24.67	21.67	21.00	19.67	5.00
D	Natural "	14.25	12.50	12.67	11.25	3.00
	Maximum "	19.44	16.78	18.11	17.22	2.22
E	Natural "	21.83	19.50	19.75	19.67	2.16
	Maximum "	27.67	20.22	20.00	19.89	7.78
F	Natural "	13.00	11.58	11.00	11.94	1.06
	Maximum "	16.57	15.00	14.89	13.11	3.46
G	Natural "	20.17	17.50	17.67	14.67	6.50
	Maximum "	18.56	16.56	14.56	15.56	3.00
H	Natural "	11.83	11.08	10.33	9.83	2.00
	Maximum "	14.78	12.11	12.33	12.11	2.67
I	Natural "	17.75	17.17	16.50	16.36	1.39
	Maximum "	20.78	18.44	17.67	16.67	4.11
Av. Natural "		17.38	15.32	15.31	14.84	2.54
" Maximum "		19.95	16.98	16.30	15.98	3.97
Difference,		2.57	1.66	.99	1.14	

consequently drops to that extent. And secondly, they are not able to resist the effect of the very slight degree of muscular fatigue that does enter. To do so would require an increase in effort, and of this they are incapable. That the first factor is present is of course borne out by many general observations. That as a class they cannot attend to anything very long is the statement of every observer, and is the basis of the more general view that a defective attention is their fundamental deficiency. Table XIV will give some idea as to how their attention does last, and how much it drops in this test. That the second factor mentioned was present, that is,

that they were incapable of resisting even a very slight degree of muscular fatigue, the general analysis of the results in Table XIV shows quite well. The maximum rate is, on the whole, only slightly above their natural rate. But the difference between the two rates is greatest at the beginning of the minute series. In the averages for all cases it is seen that it is more than twice as great for the first quarter minute as for any of the other three quarters. By the third quarter the two are practically the same. Now the difference in actual fatigue in the two rates cannot have been great. The rates are only slightly different, and both are slow enough not to permit of much fatigue. Yet to the only very slight difference there could have been they have promptly reacted, by slowing up in their maximum rate faster than in their natural rate. These facts taken together can mean only one thing, viz., that they are almost absolutely incapable of any voluntary effort whatsoever. From this it follows, as the results also show, that there is no such thing with them as genuine, normal fatigue. They can never be made to work hard enough in the first place to make much fatigue possible, and they so promptly react to the slightest degree of it as to shut out its further possibility. A comparison of the poor with the good cases indicates also that the poor have reacted to fatigue more than the latter. As was already seen in Table XII, the poorer cases, A, B, C, and I, increased their maximum rate over their natural rate less than did the others. In Table XIII, the average number of taps the good increased their maximum over their natural rate in the first quarter minute is 3.19. The same average for the poorer cases is 1.81. The average number of taps the natural rate of the poorer cases has decreased in the fourth quarter compared with the first quarter is 2.54. Their decrease for the maximum rate is 4.15. For the better cases these averages are 2.96, and 3.83 for the natural and maximum rates, respectively. But both these figures are too high on account of the exceptionally high decrease of 6.50 for G's natural rate, and the exceptionally high decrease of 7.78 for E's maximum rate. Thus the cases that stand higher in general development have kept up their rate better than the others in both natural and maximum rates, even though they have increased their maximum rate over their natural much more than the poorer cases did.

The tests in regulated tapping gave a rough means of determining during what part of the minute series their attention was best, by showing in what five-second intervals they get in the correct number of taps oftenest. The next table gives these results. In this table are given merely the number of times each case made the correct number of taps for the differ-

ent five-second intervals, from the first to the twelfth. The fig-

TABLE XIV.

	1	2	3	4	5	6	7	8	9	10	11	12
A	4	5	7	6	8	5	6	3	3	2	3	2
B	5	5	6	4	5	4	4	4	3	3	3	5
C	5	10	11	9	8	8	10	7	8	10	6	9
I	7	12	12	10	12	7	9	7	6	7	5	9
Av.	5.25	8	9	7.25	8.25	6	7.25	5.25	5	5.5	4.25	6.25
D	7	8	11	13	11	7	10.	13.	11	11	10	11
E	2	3	1	2	0	3	1	2	1	1	2	2
F	9	11	10	7	10	12	10	10	7	9	10	7
G	1	9	8	8	7	9	5	7	8	9	7	9
H	7	11	11	11	13	12	12	13	12	13	12	12
Av.	5.2	8.4	8.2	8.2	8.2	8.6	7.6	9	7.8	8.6	8.2	8
Gen. Av.	5.22	8.22	8.56	7.78	8.22	7.44	7.44	7.33	6.56	7.22	6.44	7.33

ures are based upon fourteen one-minute series for each case. Thus A, *e. g.*, had fourteen chances to make the correct number of taps for each of the five-second intervals, and got it correct 4, 5, 7, etc., times for the first, second, third, etc., intervals. In dividing the cases into poor and good again, there is one exception in each group in the test. I, although poor in general development, tapped very regularly, as will be remembered, and thus did better in the regulated series. E, although standing much higher, generally, for some reason could not do this test at all. But including the exceptions even, the averages in this table agree with what was to be expected from the preceding tables on fatigue and effort. The general averages for all cases show that their attention falls at least after the fifth five-second interval. The averages are from too small numbers to be very regular, yet in the two groups of cases it is seen that, although there are as high averages for the poorer cases during the first half minute as there are during the first half minute for the better ones, the averages during the last half minute drop decidedly more for the poorer cases. This goes to indicate that although their attention in its maximum may approach that of the better cases, it is less regular, and far less persistent. How much this change during the second half minute is due in both instances to muscular fatigue, and how much is really a fatigue of attention, cannot, of course, be said.

2. *Association and Discrimination Time.*

The means that can be employed in determining association time always involve some form of reaction. For the subject can manifest that he has an association only through speech, or through some other muscular movement. Consequently it is impossible to measure association time directly. The time that we do measure always includes the time that it takes to

give expression to the association. And, more important than this, we have no means of determining how much the particular mode of expression otherwise interferes with the associative process whose time we are attempting to measure. In considering the association time of feeble-minded children, the first thing that we need to bear in mind is the probability that the long association time that our figures will show is due more to their slow way of expressing their associations than to any slowness of the succession of imagery, because of the great lack of effort with which they proceed. For this reason I have classed the following tests under the heading of 'Attention and Effort,' rather than by themselves, although by the method employed, I believe a large part of the source of error mentioned has been eliminated.

Some experiments have been made on the association time of feeble-minded children. Johnson[1] employed the following method: A key word was called and the child was requested, in the written tests, to write down everything for thirty seconds that the word suggested. In the oral tests the suggestions were spoken. In a written test on fifteen children, average 15.8 years, he got an average association time of 8.3 seconds. In an oral test on thirty children, average age 13.3 years, he got an average of 5.35 seconds. On normal children Cattell and Bryant got, by the written method, an average of 4.5 seconds. Johnson got an average of 2.6 seconds for ten normal boys, by the oral method. Wreschner[2] has made a very exhaustive study of the associations of one case, age 22 years, using Sommer's classified list of words, designed for the purpose, for key words. He used the oral method. His main object was a qualitative study of the associations, and only the first association for the key word was recorded. Space will not permit a full statement of his results, but in his average the association time is somewhat lower than Johnson's with the oral method. It is clear, I think, that none of these figures are to be taken as measuring the actual association time. In the written tests the largest part of the time must have been taken by the writing, and when we remember that with feeble-minded children writing is, as a rule, apt to be more of a laborious task than with normals, this becomes still more evident. However, the figures do not lose their value when compared with the results of normals obtained under the same conditions. They are a fairly good measure of the degree of effort that has been put into the task.

In my own tests it was attempted to eliminate as far as possible the source of error that results from the lack of effort with which feeble-minded children proceed in any task. The re-

[1] Psycho-Asthenics, Vol. II.
[2] Allg. Zeitschr. f. Psychiatrie. Bd. 57, 1900.

sults themselves will show best how far this has been successful. The first test consisted in the child naming ten object pictures as fast as he could be made to do so. The pictures were those that had been used for over a month in the memory span test. They were placed upon the table before the child under a card-board cover. When ready the cover was quickly removed, and the child named the pictures as I pointed to them, they being pointed to at a slightly faster rate than he could name them, in order to further prevent his lagging in effort at any time. With the pictures, as in the following tests, ten trials were given to each case, but generally not more than one a day. In order to prevent their becoming weary of the test the days on which the trials were given were scattered at irregular intervals over about two months. The other tests consisted of discrimination-time tests. On twenty-five blank-faced playing cards were pasted five geometrical forms, cut from five different colored papers, so that each form appeared five times, once in each of the colors, and each color appeared five times, once in each of the forms. The colors were standard red, orange, yellow, green, and blue, and the forms a triangle, square, circle, diamond, and oblong, all solid and averaging about an inch in diameter. The first thing consisted in determining the mechanical time; that is, to see how long it would take the child to take hold of each of the twenty-five cards, turn it over, and place it upon the table. The cards were handed to the child as fast as he could take hold of them. The second time the child was requested to sort the cards into five piles, according to color. The third time he sorted them according to form. In all of the tests the time was taken with a stop-watch, and the usual means of encouraging a maximum rate were employed. In the discrimination-time tests three trials were given a day to each child, so that one trial on mechanical time, one on color discrimination, and one on form discrimination, came on the same day. Ten trials in all for each were given to each child, but scattered over two months of time, as in the tests on naming pictures. To parallel these discrimination-time tests with a similar one, the same procedure was repeated during the same two months with twenty-five object picture cards, five each of five different pictures, taken from the ten that were being used in the other tests. The mechanical time was also taken ten times for each child with the picture cards, they being less smooth and not so easily handled. The object of the discrimination tests was, first, to determine the time it would take the child to recognize a color, form or picture and associate it with its proper place on the table. The mechanical time involved in merely taking hold of the cards, turning them over and placing them upon the table

would be the same in all, so that the time in the mechanical time tests could be subtracted from the time in the other tests and obtain the actual discrimination time. Secondly, the tests were made with colors, forms and pictures because it was conceivable that this time might depend much upon the kind of stimulus used. It might be considerably shorter for things with which the child was quite familiar than for others. Table XV gives the results.

TABLE XV.

	A	B	C	I	Av.	D	E	F	G	H	Av.	Gen.Av.
Naming pictures,	1.60	1.30	1.35	1.62	1.47	1.79	1.19	2.03	1.06	1.39	1.49	1.48
Discrim. "	1.69	1.71	1.25	1.46	1.53	1.49	.99	1.69	1.28	1.54	1.40	1.46
" colors,	2.31	2.04	1.85	2.80	2.07	1.30	.90	1.34	1.23	1.29	1.41	1.67
" forms,	——	3.18	——	2.64	2.91	1.45	1.12	2.00	1.37	1.72	1.53	1.93
Averages,	1.90	2.06	1.48	2.13	2.00	1.51	1.05	1.78	1.24	1.49	1.46	1.64

These figures express the average time in seconds it took each child to name one picture, discriminate a picture, a color, and a form. A and C could not be taught to sort the cards according to form after they had done it once or twice according to color. For some reason that I could not determine, they seemed not to be able to understand what was wanted, would mix up all the forms when told to sort them, and could not be taught. Consequently the test had to be omitted for these two cases. On account of sickness, C's averages in the second and third horizontal columns are from seven and five trials, respectively, instead of from ten. On account of a partial red-green color blindness of I his average of 2.80 is left out of the general averages. The first thing to be noted about the results is the fact that they are decidedly lower than the lowest average Johnson obtained from children much older. The general average for all cases and all methods is only 1.64 seconds as against 5.35 seconds, the lowest average Johnson obtained. These low figures are perhaps in part due to the constant individual coaxing and encouragement each child received in my tests. But it is undoubtedly much more due to the other differences in the method. The averages are still higher than they would be with normals when the same method is employed, but it is also evident that the source of error resulting from lack of effort in performing the task has not been entirely eliminated. It is not eliminated in the test on naming pictures. And in the discrimination-time test it is not entirely eliminated in that in the mechanical-time tests they dropped the cards practically all on one pile, often hardly taking hold of them at all, while in the sorting tests they had to keep the cards separate in five piles, necessitating taking hold of each card properly and also a slightly greater arm movement. These matters considered, it becomes probable that their actual association time is not so very much longer than that of normals; at least it is evident

that the difference is not nearly so great as might have been supposed from previous results.

An interesting part of the results is the fact that their discrimination time is different accordingly as pictures, colors, or forms were used. The averages for all cases show that it is shortest for the pictures, and longest for the forms. The pictures were chosen as something with which they would be very familiar, they having used them a long time in the memory span test, and because they showed a decided interest in them, the object being to see whether familiarity and interest would have any effect upon their discrimination time. The results show that they did shorten it. Why the discrimination time for form should be longer than that for color is in part accounted for by the fact that their institutional training had laid somewhat more stress upon color training than form training. But another factor enters also in that form can be less easily discriminated in the peripheral field of vision than colors, and this had to be done when the five piles were kept separate on the table by a few inches. In comparing the discrimination time of the poor cases with the better ones again, it is seen that it is longer for the former, being 2.00 seconds in the general averages as compared with 1.46 seconds for the better cases. Furthermore, the difference in picture, color, and form discrimination time is considerably greater for the poorer cases. This fact is in accordance with the previous results in the memory span, in which it was seen that they could remember some pictures decidedly better than others. We shall see the same fact again in an attention span test.

These tests were not of a nature to show practice effect very much. And the element of getting tired of the task was quite effectively ruled out by scattering the tests over a long period.

3. *Attention Span.*

The attention span test consisted in determining how many things the child could see and recognize when those things were presented for a fraction of a second only, so that there was no opportunity for the attention to move from one to the other, but all had to be attended to simultaneously. The things presented were form and color, the same that were used in the discrimination-time tests, except that they were mounted on 6x8 card-boards to fit the apparatus. The apparatus was a large disk tachistoscope, set so that it would expose the form and color cards for something less than a fifth of a second. The cards were arranged in three groups, with five in each. On each of the five in the first group was one form in one color. Those in the second group had each two forms in two colors.

Those in the third group had each three forms in three colors. The combinations were as follows:

A					B					C				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.t.	O.s.	Y.c.	G.d.	B.o.	B.t.	R.c.	O.c.	G.t.	B.d.	R.s.	Y.t.	O.t.	R.c.	B.t.
					G.s.	O.d.	Y.s.	Y.o.	R.o.	B.c.	B.s.	R.d.	Y.d.	G.s.
										G.d.	G.c.	Y.o.	O.o.	R.o.

A, B, and C = the card groups. 1, 2, 3, etc., = the 6x8 cards on which forms and colors were pasted. R, O, Y, G, and B = red, orange, yellow, green and blue. t, s, c, d, and o = triangle, square, circle, diamond, and oblong. Each of the fifteen cards, excepting 6, was shown once a day to each case for ten successive days, with an interval of three days after the fourth day. To study a practice effect card 6 was shown three times a day instead of once. In the experiment the child was seated at the table with his eyes at about the level of the position of the cards in the tachistoscope. The distance varied from ten to twenty inches, each child being allowed to suit himself, within these limits. Before the child on the table in front of the tachistoscope were placed the forms and colors used on the cards 1 to 15, but mounted on blank playing cards, one on each. Their number was never greater than twelve to fifteen. When all was ready the child was told to watch, his attention being called by tapping the part of the disk behind which the card would be exposed. When his eyes were upon the spot, which could be readily seen by the observer, the disk was turned and the exposure made. The child then picked out the forms and colors he thought he had seen, from those before him on the table.

During the tests it was found that the imagery, in terms of which the child recognized the forms and colors and by which he picked them out, differed very widely with the different cases. Not all knew all the form and color names, but all knew some. A few knew all but could not apply them correctly. Several used the color name in remembering them to pick them out, but none used any form names in this way, so far as I could find out. Thus, each apparently made a different use of the color word image, the form word image, the color visual, and form visual image. A named all the colors correctly, and also the forms, excepting the diamond. He remembered the colors by their word images, the forms probably by visual images. B named all the colors and all the forms correctly, remembered colors by the word images, but not the forms. C knew a few color names but did not always apply them correctly. He knew no form names. Consequently word images probably played no part in his memory and recognition. D used all the color and all the form names correctly, but did not

use the form names in remembering; he probably used the color names somewhat. E named all the colors correctly except blue and yellow. He knew all the form names, but applied them wrongly. Word imagery probably played little or no part in his memory. F named all colors and forms correctly readily, but did not use the form names in remembering. G named the colors correctly, knew all the form names, but applied all but 'round' and 'square' wrongly. It is doubtful whether he used color names in remembering. H named all colors and forms correctly, but did not use form names in remembering. I was considerably red-green color-blind. He knew all the color and form names, but applied none correctly always. The results on the attention span are given in the next table. The figures in this table are the average number of mistakes each case made for each card group.

TABLE XVI.

	A	B	C	I	Av.	D	E	F	G	H	Av.	Gen. Av.
A	.08	.06	.10	.04	.07	.04	.04	.14	.02	.02	.05	.06
B	1.63	1.35	1.75	1.20	1.48	1.20	.83	1.18	.45	1.03	.94	1.21
C	2.50	1.90	2.54	2.70	2.41	1.90	2.14	2.34	1.94	2.08	2.08	2.25
Av.	1.40	1.10	1.46	1.30	1.32	1.05	1.00	1.22	.80	1.04	1.02	

It will be remembered that card group A had five cards, each with one form in one color, and that each of the cards was shown ten times to each case. Thus the .08 for case A is the average number of mistakes he made with one form in one color, in fifty trials with the same. His 1.63 is the average number of mistakes he made with two forms in two colors, etc., for the other cases. In the horizontal B-column, however, the averages are from four cards only, instead of five, the results from card 6 being omitted on account of their being different because it was shown thirty times instead of ten times to each case for practice effect. No corrections have been made in the table for the chance error due to the forms and colors being picked from as small a number as twelve to fifteen. From the figures it is seen that the attention span, under the conditions of the test, lies in the neighborhood of three. Thus in the general average for all cases they have made 1.21 mistakes when four things were presented, two forms in two colors, and 2.21 mistakes when six things were presented, three forms in three colors. The C-card group was clearly entirely beyond them, since they got less than four correct, on the average, out of six. On the other hand, the small error of .06 for the A-card group must, of course, be regarded as the result of occasional accidents, and not as meaning that their attention span was slightly less than two, one form in one color. Comparing the poorer with the better cases, the average number of errors

is greater for the former, the difference being .02, for the A-card group, .54, for the B-card group, and .33, for the C-card group.

Three cases, A, B, and F, made more mistakes in form than in color. Of all the others the reverse is true. However, the differences are not great enough to show any decided preference for one or the other. From the fact that none of the cases used form names in remembering forms, so far as could be determined, and that all of them used color names it might have been expected that most mistakes would have been made with forms. But too many other factors entered to judge what the effect of this could have been.

A more marked influence than that of color as a whole, or form as a whole is seen when the individual colors and individual forms are compared with each other with reference to the number of mistakes that were made with each in choosing it when it had not been shown, and in not choosing it when it had been shown. Table XVII will show that most of the cases had two or more decided color or form preferences. That is, they would choose one color or form wrongly much more frequently than another, or fail to see it more frequently than another. The results are expressed in percentages.

TABLE XVII.

	R	O	Y	G	B	Av.	M.V.	t	s	c	d	o	Av.	M.V.
A	33	38	47	24	38	36	6.00	24	25	47	45	58	39.8	10.24
	39	50	18	33	31	34.2	8.24	31	46	40	38	32	37.4	4.72
B	21	18	8	38	25	22	7.60	21	33	48	18	27	29.4	9.08
	21	34	33	16	18	24.4	7.52	20	33	28	32	35	29.6	4.48
C	27	46	45	34	25	35.4	8.08	21	28	57	17	50	34.6	15.12
	53	26	25	38	36	35.6	8.08	35	33	32	43	25	33.6	4.32
D	23	18	28	30	30	25.8	4.24	23	15	56	12	20	25.2	12.32
	36	36	28	23	13	27.2	7.36	23	15	17	32	32	23.8	6.56
E	23	42	35	24	15	27.8	8.56	20	16	32	20	28	23.2	5.44
	20	30	17	30	33	26.0	6.00	13	38	25	10	30	23.2	9.36
F	31	36	35	13	31	29.2	6.48	39	26	45	27	50	37.4	8.72
	20	40	25	40	15	28.0	9.60	19	54	28	47	23	34.2	11.04
G	14	28	17	15	18	18.4	3.84	20	8	8	5	27	13.6	7.92
	19	16	20	18	14	17.4	1.92	8	13	14	22	12	13.8	3.36
H	21	12	27	30	24	22.8	5.04	14	41	13	20	10	19.6	8.72
	30	38	30	13	15	25.2	8.96	20	14	17	33	20	21.0	5.00
I	60	28	37	15	41	36.2	11.76	16	20	35	30	48	29.8	9.44
	34	40	40	40	29	36.6	4.08	35	33	23	20	28	27.8	5.04
Av.	28.1	28.4	31.0	24.8	27.4			22.0	23.6	37.9	21.6	35.3		
"	30.2	34.4	26.2	27.9	22.7			22.7	31.0	24.9	30.8	26.3		

The first horizontal column for each case gives the percentage of the number of times each color and form was chosen wrongly, chosen when it had not been shown. The second horizontal column for each case gives the percentages of the number of times each was not seen or chosen when it had been shown. The averages are averages of the figures in the table. In the

M. V. columns are given the mean variations from the averages. These mean variations measure the extent to which color and form preferences have been present; they being large, of course, when one or two colors or forms have been chosen wrongly or not seen very much more than the others. The averages at the foot of the table show the relative objective value the different colors and forms have had in the attention span, that is, whether there was anything inherent in any particular color or form that would cause it to be chosen wrongly or overlooked by all cases more frequently than others. These averages show that there has been no serious difference between them with reference to this matter. Of the colors blue has been least overlooked, and this was probably due to the fact of its greater contrast on the white background upon which all were mounted. Among the forms the circle and the oblong were chosen wrongly considerably more frequently than the other forms. It is more likely, however, that this was due not to a difference in objective value but rather to a difference in subjective attitude of all the cases towards these forms through associating them with things in which they had greater interest. The oblong was called 'egg-shape' by most of the cases, and the circle a 'ball.' Thus, as a rule, color and form preferences have been quite an individual matter, each case having his own. For particular illustrations, and their extent, the table itself must be studied. It will be seen that in by far the majority of instances in which a color or form has been chosen wrongly very frequently, the same has been overlooked less frequently and *vice versa*. Thus of the ninety instances in the table it is only in twenty-seven of them that both percentages stand above or below the average. The best instances of preferences are found in C and D. Thus D chooses the circle wrongly 56% and overlooks it only 17%, with corresponding averages for form at 25.2% and 23.8%. In comparing the poor with the good cases, with reference to preferences, the exceptions are so great as to make the averages somewhat doubtful. Though it is true that nearly all of the mean variations for the poorer cases are high, and that the lowest mean variations are found with the better cases, there are several very high mean variations with the latter, especially D and F.

The interpretation of color and form preferences in this test must be the same as that of the preferences found to be present in the memory-span test with pictures, and the discrimination-time test with colors, forms, and pictures. The facts are exactly parallel to those of the memory-span test.

The attention-span test afforded some opportunity for a study of practice effect. It will be remembered that card 6, in group B, was shown three times as often as any of the others. The

purpose of this was to see whether, by repetition, they would learn to associate the four things in this card, blue triangle and green square, so that when they saw one they would be certain of the others. Table XVIII gives the results.

TABLE XVIII.

	A	B	C	I	Av.	D	E	F	G	H	Av.
Av. for card 6,	1.63	.90	1.13	1.23	1.22	.63	1.03	1.33	.07	.13	.64
Av. for cards 7-10,	1.63	1.35	1.75	1.20	1.48	1.20	.83	1.18	.45	1.03	.94
Per cent. gain,	0	33	35	-3	16.3	48	-24	-13	84	87	36.4

The figures are again the average number of mistakes made by each case with card 6, in the first column, and with cards 7 to 10, inclusive, in the second column. These averages show that they have learned, to various extents, the combination in card 6. The exceptions to the rule of improvement in I, E, and F are quite unaccountable. But the percentages of gain or improvement for card 6 are decidedly less for the poor cases than for the better. Even taking the large exceptions of E, and F into account, the average percentage improvement for the better cases is 36.4, as against 16.3, for the poorer cases.

In comparing the number of mistakes made in the first half of the test, the first five days, with the number made in the last half, the last five days, some practice effect is seen also. Table XIX gives the results.

TABLE XIX.

	A	B	C	I	Av.	D	E	F	G	H	Av.	Gen. Av.
First half,	126	107	129	132	124	96	89	110	61	79	87	106
Second half,	117	72	107	90	97	75	84	113	57	70	80	85
Per cent. gain,	7	33	17	32	22.2	22	6	-3	7	11	8.6	15.4

This shows that there has been in this test a considerable improvement with practice. It is, however, not to be taken as a contradiction of results in the other tests, which indicate that their practice curve goes downward instead of rising, as due to their becoming tired of the work. Undoubtedly they also became tired of the present test. But the occasion for improvement was greater in this test than in the throwing and tapping tests, enough greater to overbalance the effect of the other factors. The table also shows that the amount of improvement for each case has been more dependent upon his proficiency in the beginning than upon the general grade of the case. The poorer cases have improved much more, on the average, than the better ones. In one instance this can be accounted for by direct observation. Case I made 132 mistakes during the first half and only 90 during the last half. This was due to the fact that at first he so frequently chose forms of the same color. Thus in the C-card group, in which three forms in three colors

were shown at a time, he would see one of the three colors and then pick out the required number of forms in the color he had seen, resulting in a large number of mistakes. This he finally learned not to do, and consequently his great improvement in the number of mistakes made during the last half of the test. As for the others, it is possible that it took the poorer cases longer to learn that never more than one of the same color or form was shown at a time. It is true at least that most of the better cases learned this at once. And this once learned, the occasion for improvement was decidedly lessened.

D. Domino Discrimination Test.

In general, in the discrimination of elements in a complex phenomena more factors entering into general ability are involved, perhaps, than in most any other kind of task. To this extent the ability to discriminate should be a fairly good measure of the general grade of the case. In the present test it was aimed to get a simple task of discrimination, and to supply the conditions that would make it possible to determine what factors entered in making discrimination good or poor. Two sets of double-nine dominos were used. Each set was divided into five series of ten each, so that those with the least number of spots were in the first series, and those with the most spots in the fifth. The series were used in their order from first to fifth. In the test the ten in a series from one set were placed in a small circle on the table before the child. One from the same series from the other set was placed in the centre of this circle and the child told to find the one like it in the circle as quickly as possible. The usual encouragement to go fast was employed. As soon as the child picked up the right one the one in the centre was replaced by a second, and he was told to find that one, etc., until the series was completed. If he picked the wrong one he was told that it was wrong, and the one taken was recorded. The time that it took him to complete a series of ten was taken with a stop-watch. Each series of ten was given to each case four times, unless he made no mistakes at all in the first two trials. If he got them all correct the first two times it was taken that he could discriminate all in that series perfectly. There were a few exceptions in this procedure which will be noted in connection with the statement of the results.

In the next table are given the results on the average number of mistakes each case made in each series, and the average length of time it took him to complete that series. The first vertical column for each of the five series of ten dominos for each case gives the average number of mistakes he made for the respective series. The second vertical column

TABLE XX.[1]

	I.		II.		III.		IV.		V.			
	M.	T.	M.	T.	M.	T.	M.	T.	M.	T.	AV.	AV.
A	1.5	——	2	6:10	.75	7:00	1	7:01	1.5	14:24	1.35	8:39
B	0	3:25	.5	4:21	1.25	2:29	.5	3:03	0	3:38	.45	3:23
C	3	——	5.75	6:17	2.50	6:04	.5	4:05	——	——	2.94	5:29
I	2.75	4:33	4.00	6:38	1.75	6.07	3.25	4.05	2.0	6:09	2.75	5.38
Av.	1.44	3:59	3.06	5:52	1.56	5:20	1.31	4:34	1.17	8.04	1.87	5:34
D	0	——	0	1.45	0	2:20	0	2:53	.5	3:41	.10	2:40
E	.25	——	.25	2:32	0	3:01	.5	3:33	0	3:08	.18	3:04
F	0	——	.5	3:28	0	3.02	.5	4:20	2.0	3:47	.60	3:39
G	0	1.25	0	2:13	0	2:10	0	2:35	0	2:35	0	2:12
H	0	——	0	2:38	0	2:53	0	3:24	3.0	4:06	.60	3:15
Av.	.05	——	.15	2:31	0	2:41	.20	3:21	1.10	3:27	.30	2:58
Gen Av.	.65	——	1.71	4:12	.78	4:01	.76	3:58	1.14	5:46	1.09	4:16

for each of the five series gives the average time it took each case to complete the series. Thus in the first series B made no mistakes, and it took him three minutes and twenty-five seconds, on the average, to go through that series once. It can undoubtedly be taken safely for granted that the normal child of their age would make no mistakes at all in discriminating dominos. The first point of interest, therefore, is that these children do make mistakes. And, secondly, the number of mistakes they make runs quite closely parallel with their degree of general development. The average number of mistakes made by the four poorer cases is 1.87, for the better cases it is only .30. Again, the time it takes them to go through a series of ten in this way is also closely proportional to the degree of general development, the general averages being 5:34 for the poorer, and 2:58 for the better cases. The best of the nine cases, G, has made no mistakes and has also the shortest time, 2:12.

A study of the character of their mistakes is more instructive. They fall into two general classes. By far the majority of mistakes were due to their overlooking one end of the block. They would get one end correct, and in the recognition of this much would forget about the other end. A much smaller number of mistakes was made through choosing by general appearance, instances of real inability to discriminate. Thus, they would fail to discriminate between a four and a six, a five and a seven, an eight and a nine, etc., on account of their similarity of appearance.

[1] It did not occur to me at once that it would be valuable to take the time it took them to go through a series, consequently no record was kept of this at first. For C the fifth series was omitted on account of sickness.

SUMMARY.

1. They have a very great lack of persistent effort and attention. They are distracted both by external stimuli, things in their surroundings, and by their own imagery and motor habits. (General description of cases, especially cases A, B, and F.)

2. In relating things from memory they mingle facts and imagination, probably as a result of their effortless thinking and a tendency to follow their spontaneous suggestions. (Results from general orientation questions, p. 402.)

3. The memory span with pictures lies between two and three, and changes with the grade of the case. (Table II.)

4. A high memory span for pictures is not correlated with great memory permanency through an interval of several weeks. (Tables I and II.)

5. They show decided memory preferences, remembering some things much better than others. The degree of memory preference changes with the grade of the case, being greater for the poorer ones. With the method employed, the pictures that are forgotten most are chosen wrongly least, and those that are forgotten least are chosen wrongly most. (Tables III and IV.)

Memory preferences are probably due to differences in interest for the different things. (p. 412.)

6. In throwing at a target their practice curve goes down after the second week (Table V) through a decreasing interest in the work, and rises again when that interest is artificially aroused. (Table VI.)

7. The amount of daily variations in the throw for each week runs parallel with the quality of the throw, correlating high daily variations each week with good throwing, and low daily variations with poor throwing. (Tables IX and V.)

Daily variations are due to changes in the daily disposition. From this (6 and 7) it appears that a favorable disposition does not alone affect the quality of their work in a particular task (their surplus energy is expressed in other directions), but does so only when interest in the particular task is aroused, and, secondly, that interest can be aroused only when the general disposition is favorable. (pp. 419-420.)

8. Most cases show a constant error, throwing more in one quadrant of the target than in another, and, with most, this constant error decreases with practice. (Table VII.)

9. The regularity of their throw increases with practice; they miss the whole target less after a while, and also hit the centre less after a while than at the beginning. (Table VIII.)

10. In a minute series of tapping on a re-action key in uni-

son with a metronome beating half or whole second intervals, their practice curve goes down after the first day. (Table X.)

This decline is due to a lowering of interest. (p. 422.)

11. they get in the right number of taps slightly over half the time, when the taps are grouped for five second intervals. (Table X.)

12. In general, those whose natural rate of tapping was nearest the regulated rate, and whose tendency to vary their natural rate was least, showed the greater ability to follow the regulated rate correctly. (Table XI.)

13. The factors that entered in making them fail to keep up the regulated rate of tapping are, (a) inability to keep up the effort, (b) distractions by being attracted by things in their surroundings, and by their own irrelevant imagery and motor habits, and (c) inability to overcome their natural rate of tapping. (p. 422 and Tables X and XI.)

14. Their average maximum rate of tapping is only slightly above their average natural rate, 1.64 taps per five seconds. This difference increases with the grade of the case. Table XII.)

15. Both their natural and their maximum rates drop after the first fifteen seconds, and the two are practically alike by the third fifteen seconds of a minute series. (Table XIII.)

16. In the regulated tapping they do best after the first five seconds, and poorest during the first five seconds and the last half minute of the minute series. This tendency to do poorer during the last half minute is greatest for the poorer cases. (Table XIV.)

From this (14, 15 and 16 especially) it follows that they are almost absolutely incapable of any genuine voluntary effort in a task that they dislike, and that normal fatigue under such circumstances is impossible with them. (pp. 424-428.)

17. Their average association and discrimination time with the methods employed is 1.64 seconds. (Table XV.)

18. This time varies very much with the method emploedy. (p. 428-429 and Table XV.) It is shorter for things with which they are more familiar and have the greater interest, shorter for familiar pictures than for colors, and shorter for colors than for forms. It changes with the grade of the case, as does also the difference for the different methods. (Table XV.)

The time obtained with any method is probably much too long, and does not express the real association time because of the lack of effort with which they proceed in any test. (p. 429.)

19. Their attention span for form and color, and with an exposure of one fifth to one sixth of a second, lies between two and three. It increases with the grade of the case. (Table XVI.)

20. Making more color than form, or more form than color mistakes is an individual matter with each case. Four cases made more color than form mistakes, five more form than color mistakes. (p. 435.)

21. They have color and form preferences, choosing some wrongly more than others, and not seeing some oftener than others. In most instances the colors and forms that are chosen wrongly most are also those that are not seen least, and those that are chosen wrongly least are those that are not seen most. (Table XVII.)

The explanation for this is the same as that for memory preferences for pictures. (p. 436.)

22. Their attention span is raised with practice through their learning the combinations of forms and colors presented (Table XVIII), and probably also in other ways (Table XIX). Their ability to learn the combinations increases very much with the grade of the case. (Table XVIII.) Their general improvement is dependent more upon their lack of proficiency in the start, and is greatest for the poorer cases. (Table XIX and p. 437.)

23. They cannot discriminate dominos from each other by the number and arrangement of spots, at first, but learn to do so in time. The number of mistakes they make, and the time it takes them to match a given number varies very much with the grade of the case. (Table XX.)

24. The character of their mistakes falls into two classes: (a) overlooking one end of the block, more frequent, and (b) failing to discriminate in cases of similarity of general appearance, less frequent. (p. 439.)

The present investigation was undertaken at the suggestion of Prof. E. C. Sanford. It is a pleasure to acknowledge my indebtedness to him for constant advice and many valuable suggestions. Also to Dr. Alexander F. Chamberlain, Acting Assistant Professor of Anthropology, Clark University, for making the physical measurements of the cases for me; to Dr. J. W. Slaughter, Docent in Æsthetics and the Philosophy of Evolution, Clark University, for helping me in giving the tests; to Dr. Walter E. Fernald, Superintendent of the Massachusetts School for Feeble-Minded Children, for permission to work on the cases, and for the use of his fine special Library; to Dr. Wallace and Dr. Ladd, physicians of the institution, for selecting representative cases for me; and to matrons and attendants of the institution for helping me in various ways.

Appendix and Bibliography.

The literature on arrested development is voluminous. I

have not attempted to give any statement of it, and shall not do so now. In 1891 Sollier writes in the preface to his "Psychologie de L'idiot et de L'imbecile" as follows: "The bibliography on idiocy, very poor in France, very rich, to the contrary, in America and England, consists especially of documents on the causes, the classifications, physical signs, the pathological anatomy, and education of idiots. Men have concerned themselves but little with the psychological side, or have repeated what has been often noted." Speaking of his own book he says: "It is the first of the kind, to our knowledge, that has been attempted." Since Sollier's writing much, indeed, has been published on their psychology; far too much, in fact, to improve the disposition of those who attempt to make use of the bibliography. For Sollier's criticism on the character of the psychological literature still holds true. Some books, quite a list of monographs, and many articles on the psychology of arrested development have appeared during the last ten years. But, with a few exceptions, it may be said of all of them that they are based upon general observations only, and deal with repetitions of a relatively few facts that can be readily observed by any one, or that have been frequently stated. It is not my intention to depreciate the value of these observations; they are undoubtedly valuable. But they are not the results of a method that can take us very far into the real science of this branch of mental pathology. The time has come in this field, too, for general observation to take a subordinate place to the more refined procedure of experimentation. Upon the basis of its success and its results we both feel the need, and can judge somewhat the possibility of experimental study. Some experimental work has been done. But it is very little, and the method has hardly as yet seen its beginning in this field. Most of its results have been quoted, or referred to above; the whole is not sufficient to justify a review.

I shall not attempt to give a complete bibliography on all the phases of the subject. Such would be quite useless on account of its very cumbersomeness. But for the sake of keeping the literature somewhat in view, references are given, first, to the larger bibliographies and then to the special works arranged chronologically.

Index Catalogue of the Library of the Surgeons-General's office, U. S. Army. Vol. VI, 1885, pp. 775-782; and Vol. VII. (Second Series), 1902, pp. 816-827.

Index Medicus. Vol. I, 1879, to Vol. XXI, 1898-'99; and Vol. I, 1903. References to the different phases of mental and neural pathology of arrested development will be found *passim*.

Bibliographischer Semesterbericht der Erscheinungen auf dem Gebiete der Neurologie und Psychiatrie. Vol I, 1895, to Vol. IV, 1898. References will be found *passim*.

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Neurologischer Centralblatt. Beginning with Vol. 20, 1901, this gives a monthly, or bi-monthly classified bibliography, including sections with references on mental and neural pathology of arrested development.

Only a small percentage of the literature is psychological. During the last few years methods of training, and pedagogical principles to be applied in rearing these defectives have received a large amount of attention; perhaps an undue amount. The following references include books, monographs, and some of the more important articles concerned with their psychology and pedagogy. They are based upon general observations, and are written for the most part for superintendents, physicians, and instructors in the special institutions, and for parents.

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